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Wm. W. Ludden

FOSSIL RESINS:

A COMPILATION.

BY

CLARENCE LOWN and HENRY BOOOTH.

NEW YORK:

PUBLISHED FOR THE COMPILERS BY

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PREFACE.

THIS book is the result of an attempt to collect and put together the scattered notices on fossil resins, exclusive of those on amber. We believe that this has not been attempted as yet, and must therefore give this as an excuse for the various shortcomings which may be detected by the reader.

The articles published on this subject are to be found among the bulletins and proceedings published by various scientific societies. Many of them are to be met with only after a tedious search, and some cannot be found at all, except perhaps in the great libraries of the world, which are inaccessible, save to those who live near them. No attempt has been made to condense the various papers into a whole, it seeming preferable to let each author speak for himself, and allow the reader to draw his own conclusions.

The material here presented is lamentably meagre, but it is all there is.

The very origin of the application of the name "Copal"

to the various varnish resins cannot be pointed out. For instance, —

“The English Expositor, ’ London, 1663, gives

“Copal. A white rosin of much brightness, brought from the West Indies. The people there were wont to make perfumes thereof in their sacrifices.”

“The English Dictionary,” E. Coles, London, 1708, gives

“Copal. A perfume of white rosin, from the West Indies.”

“Webster’s Dictionary,” 1876, gives

“Copal. (Mexican, Copalli, a generic name of resins. Clavigero.) A resinous substance flowing spontaneously from two trees found in the East Indies and in Central or Southern America (*Elaeocarpus copallifera* and *Rhus copallinum*), used chiefly in the manufacture of varnishes. Ure.”

In some cases, notably that of Dalman, the locality from which the insects described have come is not given. This is to be regretted, as it gives no definite habitat to the insects described and figured. An interesting field for the entomologist lies waiting here. Little has been done toward the examination and classification of the insects contained in these resins, although some of them are exceedingly rich in inclusions. It is probably true at this day, as it was when Dalman wrote, that the smaller insects of those countries, wherein the fossil resins are to be found, have escaped the attention of entomologists who have reported on those regions. However this may

be, there is an abundant opportunity for work in a little explored region.

There are but few collectors of these beautiful objects. The pieces in the rough, as they come into the market, are not easily procured, unless especial facilities are granted to the collector, and the labor of cutting and polishing the pieces is very tedious. But when the pieces are properly cut and polished, the reward is commensurate to the labor.

The thanks of the compilers are due to Mr. G. F. Kunz and to Mr. L. P. Gratacap for assistance and advice kindly rendered during the preparation of the book.

CLARENCE LOWN.

HENRY BOOTH.

POUGHKEEPSIE, N. Y., 1891.

INTRODUCTION.

THE varnish resins or "gums," as they are called in the trade, all have peculiarities as to outward appearance, by which they may be readily distinguished by one at all experienced in handling them, but none have the characteristics so strongly marked as the Zanzibar Copal.

This has the pebbled surface, sometimes known as "gooseskin."

Opinions differ as to the causes which produced this surface, and it may be worth while here to give our theory.

This resin always comes to this market, cleaned by having, as we understand, been washed in some alkaline solution which loosens the outer coat, so that it may be more easily removed by brushing or scraping.

We wanted to see how it looked in its crude state, and some years ago, by the kindness of a friend, we received a small lot of it, just as it was dug from the ground, sent to us direct from Zanzibar. This resin has a crust over it of a rusty brown color, pebbled exactly as in the case of the resin which comes into the market. This crust is about one-sixteenth of an inch thick, full of cracks between the granulations, and so loose that much of it may

be removed by rubbing in the hands. When removed it looks much like coarsely powdered limonite. The surface under this crust is the pebbled surface we see in the resin as it comes into the market. This would seem to disprove the theory that this pebbled surface is due to the pressure of sand, while the resin was yet soft.

Experiment has shown us that pieces of the polished Zanzibar resin, placed in the window and exposed to sunlight for a year or more, have become roughened by the appearance of minute superficial checks, along the edges of which the resin scales off, leaving small rounded protuberances, similar to those on the typical Zanzibar resin, though not nearly so prominent. If, after so slight an exposure to the air and light, this approach to a pebbled surface will appear, it seems reasonable to believe that the resin, long buried in the soil, will, through loss of its volatile parts, shrink at the surface, becoming full of small cracks, and that moisture entering these cracks will cause oxidation, and consequent breaking down of their walls. This would cause the pebbled surface, which has been accounted for in so many varying ways. We may add, in this connection, that we recently found a rubber ring, made for sealing fruit jar covers, which had lain out in the open air for some long period, the surface of which had become pebbled so as to precisely resemble the surface of Zanzibar resin. This surface was evidently caused by the cracking and subsequent oxidation before mentioned.

This is the theory we hold as to the cause of the peb-

bled surface of Zanzibar resin. It may or may not be the true explanation, but it seems a reasonable one. It may be asked why other fossil resins do not show the same surface. If the resins from North Coast, Madagascar, or Demerara are examined with a magnifying glass, it will be seen that many of the specimens have a surface similar to that of the Zanzibar resin. The granulations are very fine, numbering from one hundred to two hundred to the linear inch, the average number on the typical Zanzibar resin is about twenty to the linear inch. Why the surface of the Zanzibar resin should be so much coarser, we do not know; it may be due to difference in age, or in composition of the resins, or to dissimilar conditions as to soil or moisture.

Kauri resin is all cleaned in New Zealand before being shipped to this country, and as the whole surface is cut and scraped with knives, we do not know what its true surface was like.

Not all the Zanzibar resin is pebbled alike, probably ten per cent. of it is different from the type, the surface being finer, like that from the North Coast, and other places before mentioned, and a still smaller percentage being much rougher. These latter are mostly nodular pieces, with the surface deeply corrugated, and of a pure transparent olive-oil yellow color. They are generally small, varying from the size of a hickory nut to that of a hen's egg, and are always softer than the type. They are perhaps a more recent resin, found in small quantities and thrown in with the true Zanzibar to help fill up.

Seemingly this resin is too soft to make a very good varnish.

A pitted surface is sometimes to be seen in Zanzibar resin, the pitting being very small and superficial, its diameter being not more than one-fiftieth of an inch. These pittings are always circular, and seen under the magnifying glass, appear to have been caused by the scaling off of minute particles of the resin.

The colors of Zanzibar resin vary from pale, almost invisible yellow, to deep yellow, brown, red, and green. Many yellow and colorless pieces have streaks and patches of brown or red across them. These pieces, so far as we have seen, rarely contain insects, though sometimes leaves or bits of wood fibre occur in them. The green-colored resin is harder than the other varieties, being nearly as hard as amber, and similar to it in toughness; it is seldom met with, occurring only in small bits. The light yellow pieces are the softest.

In a few instances the pieces of resin contain cavities partly filled with red or brown liquid, holding movable bubbles. Sometimes the body of an enclosed insect contains a movable bubble. The Zanzibar is by far the most interesting of any of the fossil resins on account of the great variety of inclusions it contains. These may be roughly described as being flowers, seeds, leaves, twigs, hair, lizards, spider webs, feathers, moss, and an endless number of insects; many of which are very beautiful, such as the moths, bright-colored beetles, etc. An interesting and rare inclusion is a dendritic form, which occurs but

in four pieces in our collection. There seems to have been a slight fissure in the resin, into which water charged with coloring matter has found its way, and on evaporation has left a deposit like the fern or tree forms so often seen in rock, or in moss agate. Zanzibar resin takes a brilliant polish, but, after long exposure to daylight, the polished pieces lose their lustre, becoming covered with minute superficial cracks.

It is not easy to classify the resin known in commerce as North Coast Copal under the various heads which are supposed to subdivide it. Angola Copal, Benguela Copal, Accra Copal, all seem to be classed under North Coast.

The resin we have examined, which is by dealers called North Coast Copal, may belong under any of the above heads, or may even belong to some other subdivision.

In color it is white to yellow, seldom being deep yellow. It is softer than Zanzibar resin, and its polished surface, after the lapse of some time, becomes warped and corrugated. The inclusions are few, chiefly small insects, and these not remarkable for beauty.

Its chief attraction to the collector lies in the fact that the larger pieces contain wavy, cloudlike masses, which, however, disappear when the resin has entirely dried. Pieces in our collection which were polished eight years ago, and which were remarkable for the beauty of the included clouding, are now entirely clear and transparent.

The Kauri resin exported from New Zealand is coming largely into use in the United States, and appears to be

gradually taking the place of Zanzibar resin, owing probably to its cheapness, as it does not make so good a varnish as the latter.

It occurs only in the Province of Auckland, in that part of the colony which lies north of the 39° of south latitude.

It is the product of *Dammara australis*, a tree which is not known to exist in other parts of the world. This *D. australis*, or Kauri tree, is the only member of the coniferous family indigenous to the island. It is straight and tall, growing to a height of from one hundred to two hundred feet, and having a girth of from ten to twenty feet. The foliage consists of leaves, instead of needles; its bark is dark colored and smooth. It is said to grow in groves or forests of huge extent. The resin which exudes from the living tree does not enter into commerce; that which is fossil, or dug from the soil, being alone sought for; its value as a varnish resin being due to long burial, as in the case of the Zanzibar and other resins.

The Kauri resin is sought for by men who make a business of it; it is found in many diverse localities, bare hillsides, swamps, and even underneath volcanic remains.

The diggers use a long steel-pointed rod, with a cross handle, for probing the ground, and on discovering a deposit of the resin, commence to dig, taking out all the resin, which is put into sacks and laid aside for future cleansing and classification. It is said to lie at a depth of about five or six feet. The pieces vary greatly in size, some weighing many pounds, while others are small.

The colors of Kauri resin vary from colorless, to yellow, to dark brown. It is generally clouded, and frequently contains bits of bark and wood. We have seen mention of insects and other like forms in this resin,—but nothing of this kind has come under our personal observation.

It is not so hard as Zanzibar resin, and after long exposure to light loses its polished surface. A full account of this resin may be found in United States Consular Report No. 4, by United States Consul Griffin, and also in an article by C. F. Gordon Cumming, entitled “Kauri Forests of New Zealand,” published in *Lippincott's Magazine*, April, 1884.

Concerning the resin exported from Sierra Leone, we have only the following extract from a letter by Mr. J. A. Lewis, United States Consul at Sierra Leone, in 1884 :

“You enquire regarding fossil varnish gum exported from this Port.

“The gum which is exported from this Port, principally to Liverpool, is called ‘Gum Copal,’ and is used in the manufacture of varnish. It exudes from the trunk of the tree, and then hardens, and is broken off by the natives and sold at from 6d. to 10d. per pound. This gum is not found anywhere except upon the tree, and, of course, sometimes has some bark clinging to it.

“The fine new gum is clear and yellow, very much resembling amber in appearance.

“According to the Customs report there were exported from this Port during the year ending Dec. 31, 1883,

452,196 pounds, valued at £13,212 5s. 10d. It pays an export duty of two shillings per 112 pounds. The above is not nearly all the gum Copal shipped from this Port, but represents only the amount landed here and paying duty. All transshipped without landing is not represented, which, I presume, would aggregate two or three hundred thousand pounds in addition to the above amount. I have no knowledge of *fossil gums* here, or of any gums found in the soil. This gum exudes and is gathered annually.

“JACKSON A. LEWIS,
“U. S. Consul.”

Of Manilla resin we have seen but few pieces. They have nothing to recommend them to the notice of the collector. They are not good in color, being very pale white yellow, yellow and brown, and having no inclusions.

The polished surface of this resin becomes warped and corrugated after long exposure to sunlight. It appears to be a resin of recent origin, coming from the Philippine Islands, but where found or how, we have no information. It comes into the market in pieces of varying size, which are sometimes so matted together in the packing-case as to necessitate the use of hammers to break up the mass. It loses greatly in weight during transshipment; this is due probably to loss of moisture contained in the resin.

Demerara resin is known as gum anime. It has been in the market in the United States for some years, but seems not to be used in any great quantity. Information

concerning it is scanty, as may be seen from the following letter and extract:

CONSULATE OF THE UNITED STATES AT DEMERARA,

March 15, 1884.

HENRY BOOTH, ESQ., NEW YORK.

Sir:—I have to acknowledge the receipt of your letter, asking certain questions concerning gums.

In reply, I have to inform you that I have collected the following answers from an American gentleman here, Mr. Lynch, who ships gum from the colony to the United States, and is a good authority on that article:

1st. Gum is found in the heart of a decayed tree; the soil sometimes contains gum that has run from the tree; usual soil, sandy.

2d. The depth varies from two to four feet.

3d. Impossible to answer,—gum found only in the decayed tree—drips not considered worth collecting.

4th. Sometimes gum has the appearance of the layers of wood—exactly the formation of the tree from which it has been taken. As a rule, not any bark is attached to the gum, only dirt from around the roots of old trees.

Hoping the above will prove useful,

I remain, yours respectfully,

PH. FIGGELMAZY,

U. S. Consul.

Extract from explanatory index to “Wanderings in South America,” by Ch. Waterton. Edited by Rev. J. G. Wood. Macmillan & Co. London, 1879:

“Locust tree,—*Hymenæa courbaril*. The bark of this

tree has but one defect,—it is rarely more than a quarter of an inch in thickness, and so is easily bent to the required form (of canoe). But it is heavier than water, so that if the canoe be upset, it immediately sinks, and cannot be raised without difficulty. It is from the locust tree that the gum anime of commerce is obtained. Very often when the tree is dead and decayed, enormous quantities of the gum may be found on the spot which it had occupied. The wood makes excellent furniture, being hard, heavy, brown, streaked with veins, and taking a fine polish.

“The tree is also known by the name of Simiri and K’wanarri.”

The foregoing letter and extract contain all the information we have been able to obtain concerning this resin. It may be inferred that the resin is recent, and not a fossil. The pieces we have examined are light yellow to dark yellow in color, and are always transparent, sometimes brilliantly so. Its hardness varies from that of Zanzibar resin to soft, some pieces being easily indented by the finger-nail. It takes a fine polish. The inclusions consist chiefly of light-brown ants; a few flies and beetles have been noticed. Bubbles are not uncommon. Some of the pieces show the imprint of the bark, being corrugated and knotted exteriorly.

With one exception, the varnish resins we have collected are more or less pleasantly fragrant, those from North Coast and Manilla being notably so, giving off their fragrance under the ordinary friction of cutting and pol-

ishing. Zanzibar resin, being harder and dryer, gives it off only under strong friction with a cloth rubber. The one exception in this respect that we have noticed is the Demerara resin. The odor emitted by this during the process of polishing is very offensive indeed, being due to the presence of the ants, which are very abundant in it, being often found in groups of one hundred or more, closely crowded together, and their bodies frequently filled with liquid.

FOSSIL RESINS.

I.

DALMAN.

“ON INSECTS ENCLOSED IN COPAL, WITH A DESCRIPTION
OF SEVERAL NEW GENERA AND SPECIES OCCUR-
RING THEREIN,” BY J. W. DALMAN.*

It has long ago been noticed that insects occurred enclosed in amber, and the fact that they were so enclosed gave rise to the belief that amber must, at some time long past, have been in a viscid state, and that it was a vegetable product, a gum, or a resin.

In course of time it became manifest, by means of further geological and palæontological discoveries, that these so-called amber insects were noteworthy, because of their seeming to be the remains of an extinct creation, the species they represent not being at present in existence.

The truth of this statement was proved, not only by the formation in which the fossil amber occurs, but also by the relation borne by the enclosed insects to the species now found in those localities from which amber is obtained.

In due accordance with the analogy between the products of earlier formations and those now existing, much

* Published in Transactions of Royal Academy of Science for the year 1825 (Stockholm, 1826), pp. 375, 410.

resemblance may be found between these amber insects and insects now living.

It can also be shown, that they may be referred to still occurring genera, but none of their species which have been defined seem to entirely correspond to any now known to be in existence, that many of them belong to orders which now exist only in far more southerly regions,* and that there seem to be forms among them which we may seek in vain to identify with any genera now living.†

This has given a far greater interest to the examination of the amber insects, and the lack of truly scientific research or investigation in this matter might excite surprise were it not so apparent that a richer and less laborious occupation is offered to entomologists in the study of the species and modes of life of the numerous insects now existing, beside the difficulties to be met with in endeavoring to scientifically define the amber insects.

These difficulties arise from the dull condition of the amber, the position of the insects, or the broken and en-

* Schweigger found in amber a scorpion, of which order no species is now to be found so far north as Prussia. Schweigger's *Beobacht. auf Naturhist. Reisen*, etc. Berlin, 1819. 4°. P. 117, Tab. VIII. Fig. 69.

† For instance, the strange Apterion described by Schweigger, and depicted *l. c.*, p. 113, Tab. VIII. Fig. 71; and also a spider described by the same author.

This spider seemed to differ in its essential characteristics not only from all genera, but from the Arachnidae. It had the head and thorax distinct, instead of joined. Schweigger, *l. c.*, p. 112, Tab. VIII. Fig. 68.

tangled condition of their parts. It is really fortunate that instead of uncertain or defective accounts on this subject, there are none to be found. For from the former, false conclusions might be formed in regard to other scientific questions, as, for instance, in the comparison of geological relations, in the study of temperature and climatic questions and changes, in the so-called insect geography, in the study of the analogy of organisms, etc.

It seems to be settled with some degree of certainty that amber was originally a resin,* that this resin exuded abundantly from trees, and that these trees belonged to the Dicotyledons.†

Nor is there any doubt that these trees no longer exist in those regions where amber is found, i.e., the shores of the Baltic or other parts of Europe, for in this part of the world there grow no trees which yield any resin analogous to amber. Such a condition is less rare in other parts of the world. In North and South America, in Africa, and Asia, there are varieties of trees which exude abundantly a clear, fluid gum, which retains its clearness or transparency when solidified, and becomes not unlike amber in appearance, as well as in the fact of its containing insects.

* Taken in a general sense, as Copal is not properly either a resin or a gum.

† Compare, for instance, Schweigger's *Bemerkungen über den Bernstein*, in the work already cited, particularly on p. 105, et seq., describing the fossil branches of the amber tree found in Prussia, stating the thickness of the bark, describing the inner texture or as much of it as is still apparent, and the relation which amber bears to these.

In commerce many of these gums or resins are known by the general name of Copal.

These insects enclosed in Copal offer a not unimportant field for comparison and conclusion, in connection with the question as to whether the amber-producing tree and the insects enclosed in its resin are really prehistoric, or whether they are still to be found in other parts of the world,—those which formerly grew in the North having become extinct on account of climatic changes, or whatever other hypothesis that may be assumed. If it be supposed that amber insects are still in existence, it is reasonable to say that they might occur in these resins, which are analogous to amber, and should any species be found in these resins completely corresponding to those in amber, strength would be added to the hypothesis (which otherwise is scarcely tenable) that the amber-producing tree may yet exist in other climates, and therefore that amber itself may be produced in other climates,—the condition in which it is found here being due to the effects of time and certain chemical changes.

If, on the contrary, close comparison between the insects enclosed in amber and those contained in Copal confirms the fact that among the latter no species has been discovered corresponding to those in amber, the above-mentioned hypothesis loses its last support: and the theory which asserts amber and the amber insects to be productions of a prehistoric period, gains, in addition to the geological evidence which supports it, further evidence from entomology.

As in the examinations necessary to gain a desired result, that of the amber insects is the more difficult, needing an eye trained by previous practice, it is permissible that the study of the Copal insects should come first, being easier and having greater resources.

The examination, which for some time past I have made of these, has, aside from what may hereafter be learned for comparison with amber insects, given me several interesting results, which are here presented. There are two causes for this :

I. That Copal is obtained from countries the insects of which have as yet been little examined.

II. That in Copal there are found enclosed, and frequently well preserved, species so small and insignificant that they have been omitted from collections made in those countries.

It so happens that, among these Copal insects I have discovered and defined, there are not only species which were previously unknown, but also new genera.

Before describing these, I should give a brief account of the substance in which they are enclosed.

As I have already stated, the term Copal includes a number of different gums and resins,* resembling each other, but having a widely different origin. The one of these most commonly bearing this name is the American Copal, formerly regarded as being obtained from *Liquidambar styraciflua*,† but which according to later accounts

*In fact, neither a gum nor resin, as Copal differs from the characteristics of both.

† English Encyclop. Method. Botan., Vol. III. Part II., p. 533.

is obtained from *Rhus copallinum*,* a tree which, so far as we know, is found only on the American Continent. Another Copal, yet more esteemed, comes, according to Jussieu, from India and the Orient, and is supposed to be the product of *Elæocarpus copallifera*.† Still another Copal is represented as coming from Guinea, being dug up from the sands by the river banks;‡ and Schweigger tells of a similar substance sold in England.

This substance comes from Chili, where it covers the trunk of a hitherto undescribed tree, being sometimes a foot thick. |

From such different parts of the globe and from such dissimilar trees are derived the substances usually called Copal. According to Hernandez, the gum called by this name in South America is obtained from no less than

* *Rhus Copallinum*. Willden, Spec. Plant., Vol. I. Part II., p. 1480 Torrey, Flora of U. S., 323, & Roemer et Schultes, Vol. VI., p. 647.12. Of the order *Rhus*, according to Roemer and Schultes, 76 species are defined, among which a few of those found on the Old Continent yield a product somewhat resembling Copal.

† Diction. des Sciences Naturelles. Tome X., p. 811.

‡ Chemisk. Handbok, ved. Nich. Tychsen, L., p. 44. Hagen, Lehrbuch der Apotheker Kunst, I., p. 232.

| In England I saw a piece of resin, sold under the name of Copal, which exceeded in size an ordinary piece of amber, and which was shaped as though molded in one piece, not being composed of various layers one on the other. Pieces of this resin shown to me by the noted naturalist Sowerby were full of insects (flies, mosquitoes, ants), transparent and colorless as water, resembling amber in this respect. The traveller who brought it from Chili assured Mr. Sowerby that this resin often covered the tree-trunks to the depth of a foot. He could not name the tree. Schweigger, Beobacht. auf Naturhist. Reisen, p. 103.

eight different kinds of trees.* According to Piso, it seems that the name Copal is a term used in America to designate scented gums or resins in general.

As we are yet without any definite comparison between these Copals, whose origin is so widely different, and have no account of their essential differences or peculiar characteristics, it is, at present, not possible to locate the Copal which I have examined.

It was bought in large quantities in London, several years ago, for the use of some pharmacists in Stockholm. I have been unable to discover from what country it was originally obtained. In the "Dictionnaire des Sciences Naturelles," there is an account of the Oriental Copal, which states that it is obtained in pieces of various sizes, the largest of which does not exceed the size of a nut.†

The Copal I have examined differs greatly from this, as it consists of pieces as large as one's fist or opened hand.

It was already divided into two classes, with regard to color and transparency. The pieces in the first class were as transparent as water, and enclosed but few insects; the pieces in the second class were more or less yellow, varying from pale wine yellow to dark honey yellow, and contained many insects. Both classes of this Copal were quite clear and transparent, though the outer surface is sometimes opaque; the pieces are of indefinite

* Thomson, *Syst. de Chemie* traduit par Riffault. Tome IV., p. 157.

† It is sold in pieces of various sizes, the largest of which do not exceed a nut in dimensions. *Dict. d. Sc. Nat.*, T. X., p. 310.

shape, being sometimes in small cylinders, and sometimes in a form that gave indisputable evidence that they had at some time adhered to, or around, some stalk. The most common form, however, was that of spread pieces or plates, with occasionally several layers, one over another.

There may, moreover, be discerned, especially in the transparent pieces, spots or stripes of a dark red but clear color, the origin of which may have been some vegetable juice. This Copal is hard and brittle, but may easily be cut with a knife, being in this respect softer than amber. Being polished it assumes much of the brilliancy and appearance of amber, but it is paler, and frequently clearer.* When burned it gives a peculiar, but pleasant odor.

I hoped that an examination of the enclosed insects would determine from what portion of the world this Copal was derived, but was met by the following difficulty :—

These insects, being for the most part small species, have been vainly sought among various authorities—the only known species I found, viz., *Platypus flavicornis*, being, according to Schönherr's statement, one that is met with both in America and Africa. The strange and rare family *Pausus*, of which I found a species in this Copal, is, however, one of the genera which has not yet been seen in the New World, and I could not find a single

* Contrary to the statement of some authors, who insist that Copal does not admit of polish, as, for example, Hagen, *Lehrbuch der Apotheke Kunst*, I., p. 222.

species of the numerous genera belonging to South America alone, in the substance. From this it may be accepted as probable that this Copal, and the insects it contains, is derived from some part of the Old World. Comparison with the insects I here describe should throw light on the subject before long.

As the surface of the Copal pieces is opaque, it is not easy to discern the enclosed insects, especially the smaller ones, until the gum is broken.*

They are generally scattered, sometimes arranged in layers, as though they had floated on the surface in scum, as we find insects in swell ice.

A great number of the same kind often come together, frequently there is a mixture of several kinds. Though many of them lie in positions which render their examination quite difficult (a position in which the antennæ and feet are entangled, etc.), yet it is remarkable to see the free condition in which the parts sometimes lie, the thin wings unfolded, the antennæ and feet not entangled, and the fine covering of hair not compressed,—in fact the insect appears to be in its natural condition. I even found pieces of Copal which, like pictures, portrayed the ordinary life of these insects, some holding their prey in their jaws, mates still inseparable, bees with a harvest of

* If the Copal pieces be dipped in water, the larger insects become apparent. The Copal being easy to work, the pieces may be divided without especial difficulty into separate parts, which may then be filed and brilliantly polished.

The larger insects are rarer, and when found are seldom entire in all their parts.

pollen on their feet, &c. Like the inhabitants of Herculaneum, they seem to have been buried while pursuing their ordinary occupations. It may be inferred from this that the fluid Copal solidified rapidly.

Insects of all orders are thus found enclosed in Copal, even Arachnida and Oniscida; Lepidoptera are, however, rare. Forest insects seem to compose the greater portion. Ants, Termites, and Diptera occur in greatest abundance. I have not yet found any true water insect in Copal.

The smaller species are the more plentiful, and as explorers have omitted to make any collections of these, it may be supposed that our knowledge of them is confined to what may be gathered from an examination of Copal. The results I have arrived at from such an examination may be arranged under the following heads:

I. A complete analogy with those insects found in amber, and an explanation of how they became enclosed.

II. Some new insect genera, no species of which has been known, and which are a connecting link between other forms, and may be of interest in studying the analogy of genera,* &c.

III. A not insignificant number of new species, of different orders, some being of genera of which but few species have been known before, for example, *Pausus*, *Ripidius*, *Claviger*, *Platypus*, *Chelifer*.

IV. Several additions to the so-called insect geography, as,

I. That many genera, of which no species has heretofore

* New Genera: *Palmon*, *Articerus*, *Prionopus*, *Chalinura*, and perhaps one or more among the yet undefined Diptera.

been thought exotic, and which therefore have seemed native to Europe alone, are found in other portions of the world.*

II. That other parts of the world, especially the tropics, have just as great an abundance of small and insignificant insects as Northern Europe, and that the larger insects do not preponderate there, as we are inclined to believe when reading the accounts by various authors, or examining the collections in our museums. The absence of these innumerable minute foreign insects from our museums is due only to the negligence of collectors.†

III. That the so-called intrinsic parasites living on the insects of these southern climates not only belong to the same genera as the corresponding ones of the north, but also resemble them more than is usually the case with species from such different countries.‡

Before I undertake a description of the genera and species found in Copal, it may be necessary to remove any apprehension which is entertained as to the possibility of discerning the enclosed insects with sufficient distinctness to define them and give a description with scientific exactness. This apprehension may be justly entertained with

*For example, *Pselaphus*, *Claviger* (*l. Articerus*), *Aleochara*, *Psocus*, *Chermes*, *Thrips*, also the majority of hymenopter parasites, which will here be named.

†For instance, of *Pselaphi*, *Psoci*, *Cyntipes* (*f*), the parasites named below, an abundance of extremely minute *Tipulara*, *Micro-myzides*, &c.

‡Namely, the following genera, among the *Codrini* and *Pteromalini*,—*Bethylus*, *Belyta* (?), *Diapria*, *Scello* (?), *Encyntus*, *Entedon*, *Torymus*, *Pteromalus*, *Eupelmus*.

regard to a large number of the Copal insects, but among a great number of individuals, some may be found which, after the Copal has been cut down to a proper degree of thinness, seem so perfectly plain and distinct that little doubt can arise as to the character of even the finest parts. The abundance of individuals of the same kind often allows the extraction of one, thus permitting examination, and compelling conviction as to the true color and the finer marking.

By analogy, the illusion to be feared from the Copal itself may be avoided. It must be also admitted that these insects in their enclosure of clear Copal are more securely preserved from the action of time and the depredations of other insects than they would be in the most carefully tended museum, and that a part of them (either very minute species, or those of soft and changeable consistence, *i.e.*, the Arachnidæ, etc.) could scarcely be so well preserved by the usual methods.*

As a further proof of how little the appearance and fine construction of these insects are hidden or obscured by the Copal, I can cite the following instance:—In exercising greater care than usual in describing a platypus enclosed in Copal, I happened to notice that the tarsi of this family have five divisions, although preceding

* We are here reminded of the peculiar mode of preservation adopted some time ago in Germany, *viz.*, that of enclosing each insect in its individual wooden box, having a glass top and bottom, well secured with putty, by which means the insect was secured, not only from any attack by moths, but also from further examination by the possessor.

authors accept or name only four. This fact seems to establish the possibility of properly distinguishing the relations of the various parts, and the above discovery was interesting, because it seemed to point to a noticeable change in the position of *Platypus* in the system, and to strengthen the affinity between *Scarabæides* and *Bostrichini*.

As already stated, insects are generally abundant in Copal. If, then, we should have a large quantity of this substance to examine, this particular collecting of insects would soon partake of the interest and conditions attendant upon collecting from the ground. We are tempted to search particularly for the more unusual and peculiar forms, and to leave the smaller and more insignificant species for an aftermath.*

In defining the species, we have to contend with the same difficulties met with in determining others in general.

Certain orders and families, particularly as regards foreign ones, are as yet too little known, so that we are often confused in determining the genus to which some species belong.

My purpose has been to direct attention to a subject which, when further developed, may yield very interesting results.

At present I confine myself to a description of only a

* The time and labor expended in properly splitting, grinding, and burnishing pieces of Copal, make a collection of them expensive, not reckoning the original cost of the Copal itself.

few, but more clearly defined new genera and species, which have come under my observation during the foregoing examination.

I.

PALMON.

New genus of Hymenoptera, from the family Pteromalina.

Antennæ filiform, ending in a large clava inserted in the centre of the forehead; 12 jointed.

Body elongated, abdomen subclavate.

Oviduct exsert, elongated.

Posterior femora thick, denticulate below.

The genus of the Palmon is best distinguished by the form of the antennæ, namely by a flagellum, not uniform as in similar insects, but with a filiform base, and with a true clava bearing apex. Otherwise in regard to its feet it agrees with the *Leucospis* and *Chalcis*; in appearance and oviduct it is somewhat like the *Torymus*, so that I should say it was about midway between the *Leucospis* and the *Torymus*. In our arrangement, without doubt, it belongs to the first division of Pteromalina or Macromeri, though in the form of the antennæ it differs from the others of this section; neither, except improperly, should it be permitted to separate *Chalcis* from *Eurytoma*, and

it may therefore rather keep its place between *Leucospis* and *Chalcis*.

Males of this genus are unknown to us.*

DESCRIPTION OF THE GENUS.

The antennæ are inserted in the middle of the forehead, between the eyes, inclining toward each other at the base, the length about that of the head together with the thorax. In the female there are twelve joints, as follows: the first joint or scapus slightly conical, not reaching beyond the forehead, the second (pedicellus) medium sized, obovate; the following ones (three to nine) are small, nearly equal (unless the outer ones are shorter), making a filiform flagellum; the tenth and eleventh joints are close together, and scarcely separable, and form a large distinct clava, oval, and in one species almost longer than the head. *Head* of the width of the thorax or even wider, subglobose, neither furrowed nor carinate; forehead convex, mouth curving downwards. *Eyes* lateral, large, ovate; three distinct ocelli in the forehead.

Thorax elongated, neck short, of equal length throughout, scutellum not prominent, metathorax sloping. Abdomen of the length of stethidium together with the head, subpetiolate, subclavate, straight, somewhat flattened, segments 1 and 2 scarcely larger than those which follow, rather more slender.

Oviduct exsert, straight, of the length of the entire body, emerging underneath the apex of the abdomen,

* Named from *παλλω*, I vibrate; whence also *παλμος*, vibration, on account of the continual vibration of the antennæ.

usually with three hairs, as in allied genera. The fore feet are small, form simple, tibiæ furnished with minute apical spurs.

The coxæ of the hind legs are elongated, conical (longer than the head); the femora are longer than the coxæ, ovate, denticulated below, tibiæ slender, curved, closely united to the femora, with a small apical spine.*

The tarsi are all slender. The wings extend a little beyond the apex of the abdomen and are flat, the subcostal nervure meets the costal margin a little within the middle of the wing, and coheres to it for a considerable distance, but disappearing long before the apex of the wing is reached, it sends out a very short stigmatic branch, ending indeterminate.

There are no traces of discoidal nervures. The posterior wings are small, with a thin costal nervure, otherwise smooth

PALMON BELLATOR.

Dark blue, with abdomen and feet of pale dark red, with the similarly colored posterior femora very denticulate, the scapus of the antennæ yellow, the clava of the flagellum very large, brown, longer than the head. ♀ Plate I. Figs. 21, 22, 23. Habitat: One specimen enclosed in Copal, the parts being distinctly displayed. The length is scarcely one and one-half French lines, excepting the oviduct, which is longer than the body. The scapus

* Some species of *Torymi* have femora armed, but with only one tooth, nor are the femora of these thick, neither are the tibiæ curved and attached to the femora.

of the antennæ is a saffron^{*} yellow, sublinear, plainly lower than the vertex. The flagellum before the clava is a dirty yellow,* of the length of the head, much narrower than the scapus, linear, the joints being very near together; clava very large, conspicuous, oval, apex subacuminate, ruddy brown, more than twice as thick as the flagellum, longer even than that, and the head somewhat compressed. Head globular, pale blue.

Eyes large, round and red. Stethidium pale blue, polished (punctate?), neck not bent.

The abdomen is the length of the stethidium, together with the head, clavate, pale dark red, being deeper in color at the base and apex; oviduct slender, with three setæ, clearly longer than the whole body, pubescent. Feet yellow or pale dark red, knees and tarsi all being paler. The coxæ of the posterior legs are spotted slightly on both sides toward the base; femora thick, large, pale dark red, with about nine not well defined, unequal spines underneath, but smooth toward the base. The wings hyaline, tinged with a pale sooty color, with the ordinary nervure and stigmatic ramulus more obscure (Obs.) The costal nervure in the *P. bellator* is prolonged farther behind the stigmatic ramulus than in *P. clavellatus*.

PALMON CLAVELLATUS.

Palmon, obscurely blue, abdomen light brown, apex pale; feet dark red, femora obscurely so, the posterior

* The saffron or yellow colors of insects enclosed in Copal are rather difficult to determine.

being black and much denticulated; the flagellum of the antennæ is reddish, once and a half the length of the head, clava brown, much shorter than the head. ♀

Habitat: One specimen enclosed in the Copal, the hind legs bent forward, difficult to examine. It is very closely connected to the *P. bellator* in size and stature, but is not as well marked, and the form of antennæ very distinct. The scapus of the antennæ surpasses the vertex very slightly, but the form and color cannot be properly told from the specimen—flagellum with the clava a little longer than the head, terete, bright red, thicker than in the *Palmon bellator*. Clava ovate, apex subacuminate, dark brown, scarcely thicker than half the flagellum, almost half as long, and therefore much shorter than the head, and not as conspicuous as in the *P. bellator*.

Head pale blue, polished, broader than the thorax, seems larger than in the *P. bellator*.

Trunk pale blue, shining, front edge of the neck a little sharper, not bent down.

Abdomen equal to the length of the trunk, together with that of the head, clavate, very little compressed, brown, black on the base itself, and posteriorly shining with a blue color; oviduct elongated, in our specimen mutilated. Feet pale red, coxæ and anterior femora dark brown in the middle, posterior femora large, ovate, sub-lenticular, black (?), supplied with about 9 denticulæ underneath, posterior tibiæ pale red, joints and tarsi somewhat paler. Wings hyaline, somewhat tinged with a

smoky color; nervure and stigmatic ramulus dark. Plate I. Fig. 24, head with the antennæ of this species.

PALMON CAPITELLATUS.

Palmon, pale blue, abdomen brown, apex rather obscure, feet dark red, femora rather obscure, posteriors black and much denticulated, flagellum of antennæ yellow, slender, twice as long as the head, clava oblong, brown, making scarcely a third part of the flagellum. ♀

Habitat: A single specimen enclosed in the Copal.

The height and colors are like those of the *P. clavellatus*, and it is so like it, that I should consider it only a variety of the same, unless, in fact, the flagellum of the antennæ seems longer and more slender, and yellow with a shorter clava. Abdomen is pale red at the apex; oviduct pale red, of the length of the whole body.

II.

PRIONOPUS.

New genus of Curculionidæ.* *Rostrum* of the length of the head together with the thorax, rounded, curved, somewhat depressed at the apex, rather thin at the base. *Antennæ* do not reach the base of the thorax, inserted in the middle of the rostrum, first joint slender, scarcely reaching the eyes, joints 2 and 3 short, ovate, 4, 5 and 6

*According to the arrangement of Drs. Germar and Schönherr, by whom the *Curculionidæ* are divided into numerous genera, this species in other places is to be ascribed to *Rhyncænus*. Fabr.

very short, nodiform, the remaining three are much larger, though 7 and 8 are short, globose, ovate-conical at the apex, acuminate.

Body ovate, subpyriform, convex, gibbous; thorax, with the head forming a short cone, almost equal to the elytra.

Elytra longer than the abdomen, striate. Breast short. Legs strong, femora very thick in the middle part, marked below with many spines, tibia a little thicker, subarcuate, curtailed at the apex, tarsi soled, nail divided. Genus nearest to *Anthomonus* of Germar and Schönherr, but entirely distinct in its antennæ.* One species is known so far.

PRIONOPUS ACANTHOMERUS.

Pr. ovate, gibbous, inclining to ash color, two dark brown bands on the wings, oblique, wavy; antennæ, rostrum and feet being dark red, femora thickened, all bearing below four or five spines Plate I. Fig. 18.

Habitat: One specimen enclosed in Copal.

The appearance is nearly that of the *Anth. druparum*; it is a little larger, but much thicker and more gibbous. The antennæ are red, head inclining to ash color (scaly?), rostrum red, mandibles black at base. Eyes toward the base of the rostrum small, lateral, circular. Thorax short, conical, scarcely longer than the width of the base, hardly sinuate at the base, gray, two brown rings on the back. Scutellum not detected. Elytra toward the base not wider than the thorax, but soon spreading out twice

* Name from *πριον*, saw; *πούς*, foot.

as long as that, rounded at the apex, very convex, lightly furrowed, gray or ash colored, with two brown sinuate bands, the first near the base of the elytra, not reaching the shoulders, composed of three or four maculæ, of which the middle one is dilate behind. The other band is in the middle of the elytra, and almost of the appearance of the preceding one. It is to be noted that the fourth interstice from the anterior edge is elevated and carinate. The body underneath is ash colored. The feet are bright red, femora very thick, all furnished underneath with spines, of which the innermost is the longer, sensibly diminishing toward the apex.

III.

ARTICERUS.

Clearly a new genus of Coleoptera, of the family Clavigerides.*

Antennæ extended, clava elongated, cylindrical, not jointed, apex truncate. Eyes lateral, distinct, rather prominent. Appearance of the Clavigerus, mouth closed, elytra bisected. Abdomen large, marginated.

A remarkable genus, perchance to be placed at the end of the Coleoptera, the Clavigerus certainly being closely allied to it, but distinct in the clava of the antennæ,

* This genus having been discovered, the Clavigerides may by right form a family of their own; they do, in fact, differ from the Pselaphides in their antennæ, their appliances for getting food, and in their manner of living.

which are either without joints, or the joints are so close together that they cannot be distinguished ; while in the *Clavigerus* the antennæ have six joints of unequal length, separate and well distinguished. The eyes in *Articerus* are very conspicuous, placed towards the side of the head. In *Clavigerus* there are either none or they are concealed so that neither to the most observant Müller* nor to me has it ever been possible to detect their rudiments.

Altogether, the *Articerus* differs from the *Pselaphus* in the shape of the antennæ and the head and in the construction of the tarsi. Named from *απρίος*, untouched, and *κερας*, horn.

ARTICERUS ARMATUS.

Red, clava of the antennæ cylindrical, truncated, of the length of the head, the femora of the intermediate legs bidentate, the tibia unidentate. Plate I. Fig. 12. Habitat: I have examined two specimens enclosed in the Copal, alike in size, appearance, and color, of which one has the intermediate legs distinctly dentate, but the other has all the feet contracted, for which reason I cannot discern whether they are armed or not, which is also true of the posterior legs of each specimen. It is less than half the size of *Clavigerus testaceus*, more slender; the body throughout is red or covered with a shell, shining, the eyes alone being black, and with two dark spots on the back.

* Compare Müller in *Magazine of Entomology*, III., page 78.

The antennæ are inserted a little in front of the eyes, the first joint is small, obsolete, the second very large, of the length of the head, of the thickness of the femur, thinner at the base, then cylindrical, truncated at the apex, not thickened.*

The head is of the length of the thorax, rounded, thicker in front, the vertex between the eyes being marked by two dots. The eyes are black, lateral, somewhat prominent, situate in the middle of the head, very distinct. The thorax is evidently longer than it is broad, somewhat expanded in the middle, narrow in front, there being a small obsolete dorsal channel. There is no scutellum. The elytra at least more than half as long as the thorax, and even broader than that at the base, posteriorly much dilated, truncate at the apex, covering only a third part of the abdomen, flat and smooth above. I am unable to discover any marking, except perhaps a short line on each side next to the scutellum, and another longer one intramarginal. The abdomen behind the wings is of the width of these, but plainly longer, marginated, rounded at the apex; the first section is short, transverse, two black spots on the back; the posterior portion of the abdomen is smooth, covered with a fine powder.

The body underneath is of the same color, the sections of the abdomen on top cannot be distinguished, but under-

* I have reduced the pieces of Copal which enclose this insect to the greatest thinness, and I have examined the antennæ, which are transparent under the light, and yet I have in vain attempted to detect any articulation of the clava.

neath there are five. The legs are a little paler than the body; the fore legs are short, the femora of the intermediate ones are subclavate, with the posterior margin behind the medium or middle leg bidentate, subemarginate between the armatures; the tibiæ of the same pair back of the middle are armed within with a minute spine, the posterior legs seem short, but yet I cannot be assured of it, as in our specimens they are contracted underneath the body and are difficult to examine. The tarsi are very short, so that they seem to be of a single joint, but I suspect from analogy, according to the observations of Cl. Müller *, on the species of *Clavigerus*, that they have three joints.

* I here append a description of an aranea found in the Copal, which, although our specimen is mutilated, seems so singular, that, it well deserves the attention of those learned in these matters.

ARANEA (CHALINURA) LONGIPES.

Pale, abdomen ovate, lateral hairs of the tail longer than the abdomen, filiform, pubescent, feet elongated.

Habitat: A single specimen enclosed in the Copal, the legs mutilated.

Small, the length of the body (excepting the setæ) is two lines,—pale throughout, unless the color is changed by death.

Cephalo-thorax rounded, unequal, smooth on surface, the back being marked, short, pale, covered with short hair; the front tubercle being very elevated, bearing eyes. The number and arrangement of the eyes is not sufficiently clear to me on account of the roughness of the Copal, yet four disk-shaped ones are very distinct, of which the large front ones are approximate; but the four lateral ones are minute, situated farther back; but as such an arrangement of the eyes is quite unusual in the araneæ, it may be called doubtful.

The palpi are pediform, medium sized, the terminal joint being

IV.

NEW SPECIES.

I. RIPIDIUS MEGALOPHUS.

Dusky black, the legs white at the base, and also the elytra being white at the apex, the antennæ are dark, more than half as long as the body, white at base. Plate

I. Figs. 1-4.

The flabellum of the antennæ is 8 leaved.

Habitat : A specimen enclosed in Copal ; length scarcely that of two French lines.

The flabellum of the antennæ is large, reaching the apex of the elytra or breast, dark, white at base, the lamellæ being rounded at apex.

thick, ovate-acuminate. The abdomen is ovate-convex, two rows of three to four spots being marked on the back.

There are four anal papillæ, of which the inside ones are shorter and conical, the outer ones are prolonged, much longer than the entire abdomen, two jointed ; the first joint is cylindrical, a little longer than the interior papillæ ; the second is very long, filiform, slender, evidently pubescent within.

The legs are very much elongated, but in our specimen there are many imperfect ones in the Copal itself, yet the femora of all are present, except of the first pair. The femora of the second and fourth pairs are clearly longer than the whole body, but those of the third are shorter than that. The legs are all slender, short, nearly bare, the tarsi of the fourth pair at least being thin and short.

I scarcely hesitate to put this aranea into a class by itself, which I name Chalinura, from χαλινος, a bridle, and ὕψα, a tall. The long caudal hairs especially persuade me to this course, as well as the remarkable length of the legs, and perhaps also the arrangement of the eyes. I regret that the specimen, being damaged, does not permit an exact description.

Head small, deflected, black, a white spot above each eye, another above the insertion of the antennæ. Palpi hanging from the head, dark, short and inversely conical, thorax dusky black, pubescent, with the posterior twice as large as the anterior portion, subtruncate at the base, angles acute, rounded at the apex, moderately convex above. Scutellum short, transverse, rotund, dusky colored.

Elytra shortened, separated, a little broader than the thorax, reddish dark, pubescent, the shoulders being paler, rounded at the apex, white, subhyaline, and therefore distinct, as in the genus of *Malthinus*. Abdomen conical, dusky red, back between the elytra same color as abdomen, apex light colored. Wings more than half as long as the abdomen, smoky colored, nervures dusky. Legs slender, all white at the base, the tibiæ and tarsi dark colored, densely pubescent, or finely setose. In this species the coxæ of hind legs are medium sized, white, approximate, the two trochanters quite elongated, yet half as long as the femora.

The tarsi of the first and second pairs are very distinctly five jointed, of the rear pair only four jointed, compressed in all, thin toward the apex, the apical joint provided with two very minute claws.

Obs. I. The form of the thorax of this species agrees well with the figure of the thorax in *R. pecticornus*, published by Cl. Thunberg.

Obs. II. The place of this anomalous genus in the natural system is as yet hidden on account of the nature

of the tarsi, the form of the antennæ, and the elytra separated at the apex, so we have provisionally placed it near the Ripiphi.

II. RIPIDIUS PYRRHOLOPHUS.

Black, the legs dark red, elytra black on the inside, on the outside and apex they are light. Antennæ dark red, scarcely longer than the head together with the thorax. Plate I. Figs. 5-8.

The flabellum of the antennæ quinquefoliate (?).

Habitat : One specimen found in the Copal, length a line and a half, French measure. It is very near to the *R. pecticornus* of Thunb., but seems to differ in color and shape of the thorax. The antennæ are a little longer than the head together with the thorax, deep red, joints one and two being very short, the rest lamelliform, forming an equal flabellum, but with only five lamellæ of each antenna, as far as I can discover,* sub-linear, rounded at apex.

Head small, subterete, somewhat prominent, black. Thorax very short, trapezoidal, twice as broad as long, posterior angles somewhat prominent, narrower anteriorly, truncated or subemarginate. I cannot discover a scutellum. Elytra very short, separated and not produced beyond the base of the abdomen, on the inside is a black, suture-like fillet, bending inwards, but light colored on the lateral margin and entire, apex subtrans-

* In our specimen both antennæ are entire and with somewhat separate radii, for which reason it can scarcely be imagined that more are hidden, unless perchance they are too closely crowded.

parent. Wings large, white, nervures pale red. Back between the elytra and abdomen conical and black. Body underneath dusky black, legs slender, dark red, tarsi pale on the apex. Posterior legs remote from the anterior, but in turn bending toward each other. Coxæ in our specimen difficult to be distinguished, trochanters very much elongated, almost of the length of the femora, which are very short; the tibiæ of this pair are a little longer than the femora, thicker toward the apex; tarsi of the length of the tibiæ, sensibly attenuated, the joint at the base being larger, the others decreasing.

The anterior tarsi are of five joints, the rear ones seem to be supplied with only four, although the true number is brought out with difficulty.

Obs. The legs in this species are bare, very slightly ciliated, or covered with hairs, as in the *Ripidius megalophus*.

III. PAUSUS CRUCIATUS.*

Dark red, nut brown on the head and thorax, dark on the base and apex of the elytra, with suture and medial

* I have no doubt concerning the genus, but it is proper to state the characteristics which rightly distinguish it. The tarsi are slender, of the length of half the tibiæ, with four joints; joints 1, 2, and 3 minute, very short, the apical joint having the length of the others combined, having two claws. Tibiæ short. Anterior legs approximate at the base, but the posterior ones in turn separated widely from one another at their insertion.

Mouth somewhat produced. Maxillary palpi filiform, rather thick, three jointed, joints being equal, 1 and 2 slightly obovate, the base joint conical. Labial palpi very short. Lip entire. Mandibles short, pale, almost covered by the labrum.

fascia brown, antennæ nut brown, clava large and obovate. Plate 1. Figs. 9-11.

Habitat: One specimen enclosed in Copal is very well preserved and quite easy to examine, except what appertains to the anterior feet, which are withdrawn under the body.

The length of the body is scarcely one and a half French lines.

The antennæ are inserted in the apex of the head, above the mouth, somewhat removed from the eyes, of about the length of the head together with the thorax, and of a form peculiar to the aberrant Pausus. The first joint is quite long, obovate, or pear shaped; the second is small, slightly obconical;* the whole remaining portion of the antennæ forms a very large clava, thick, slightly compressed, obovate, yet swelling at the extreme apex. Yet this clava seems articulated to the well-protected eye, with its basal joint short, semilunar, the second very large, making a true clava, apex short, submamillary, tumid; all these are so closely connected that they are with difficulty distinguished.

The clava appears doubled underneath, like a snail shell. Head subtriangular, yet truncated at the apex, dark brown, smooth. Mouth with the palpi or feelers yellowish. Antennæ nut brown, joints and apex ruddy, eyes surrounded with very fine hairs. Eyes lateral, small,

* Another very short joint may be seen without any doubt at the base of the second joint, which can only be regarded as the root of the preceding one.

round, entire, a little prominent, in this specimen white, with a red spot. There are no ocelli. The thorax is broader than it is long, marginate, somewhat heart shaped, yet truncate at the base and apex, the forward angles being rounded, the rear ones nearly right-angled, convex on top (with dorsal channel?), dark brown, lateral margin and back rather colorless, or deep red, finely pubescent. Scutellum small, triangular, reddish, elytra nearly obovate, plainly broader than the thorax near the base, somewhat expanded toward the middle; narrower farther back, apex rounded, convex on the back, yellowish red, margin not well marked, and region of scutellum darkened; through the elytrum is a transverse band, brown on the back, black toward the sides, and toward the apex the band is very black, yet beyond the apex the color is reddish black. Suture reddish black, with central band forming a cross. In each elytrum, stria obsolete next to the suture. In other respects the elytrum seems smooth and impunctate and covered with very short hair. The body deep red below, spotless, smooth. A short channel on the back part of the breast, abdomen rather flat, six segments, the first much greater than the rest, the anus minute. Legs rather short, abrupt, reddish, femora not well defined, tibiae compressed, tarsi pale, testaceous.

Posterior legs in turn far removed from one another, femora somewhat clavate, not reaching the apex of the elytra, tibiae slightly curved.

IV. CERAMBYX DICHROPTERUS.

Thorax shortened, yellowish red, legs same color; antennæ of the female thick at the apex, dark in the middle, elytrum pale yellow at base. Plate I. Fig. 17.

Length five lines.

Habitat : A specimen enclosed in Copal.

The appearance and expression is that of *C. longipes* and *clavicornis* (Saperdæ, Fabr.), to which it seems nearest, the antennæ being a little thickened at the apex, but the mouth less prominent than in these. Antennæ of the length of the body, the first joint being yellow, second very short and dark, the rest nearly equal in length, rounded, covered with hair, 3 and 4 dark, the others yellow, the one at the apex somewhat thicker. The head short, yellow, mouth and palpi same color, mandibles black at the apex. Eyes a little prominent, same color as the head. Thorax a little longer than wide, a little more constricted in front than behind, shortened, yellowish red, very thinly covered with hair. Scutellum small, triangular, yellow. Elytra twice as broad as the thorax, but nearly four times as long, sublinear, a little depressed, remarkably rounded at apex, very black, but yellow to almost a third part of the base. Body underneath yellow red, abdomen more obscurely so. Legs slender, short, non-clavate, yellow red,—tibiæ and tarsi deeper colored, posterior femora shorter than the abdomen, shortened at the apex.

V. *TILLUS NIGRIPES*.*

Yellow, antennæ, tibiæ and tarsi black, elytra deeply puncto-striate; anteriorly and posteriorly smooth.

Habitat: Specimen enclosed in Copal, very well preserved. Length three lines. Antennæ much less than half as long as the body, sharply serrate, black, joints 1 and 2 being ruddy, the last one very large, short, obliquely subacuminate. Head bent down, smooth, reddish black at the vertex; mandibles dull red; palpi yellow. Eyes pale, reniform. Thorax wider in front, contracted posteriorly, yellow, covered with hair, seems smooth. Scutellum small, round, yellow.

Elytra linear-elongate, truncated at base, broader than the thorax; shoulders gibbous, back convex, apex rounded, yellow, without spots.

In front and towards the sides distinctly and quite deeply puncto-striate, polished posteriorly. Body below yellow, abdomen dark. Wings black. Legs elongated, covered with hair, femora yellow, the entire anterior tibiæ being black,—the rear ones only at the apex.

All the tarsi are black, soleated, structure as in the rest of this family.†

* I have little doubt concerning the genus, as there are four unequal palpi, the front ones short, filiform, joint at the apex ovate-obtuse; posterior ones longer, joint at the apex clearly ax shaped. Antennæ very serrated, joint at apex ovate-acuminate. Mandibles strong, 2-3 toothed. Eyes marginate near the insertion of the antennæ. Body thinly covered with hair. Thorax somewhat heart-shaped, and subcylindrical as in *T. elongatus*.

† Among the numerous species of the Coleoptera enclosed in the Copal, we have more frequently observed the genera *Bostrichus*

VI. BLATTA PERSPICILLATA.

Ovate, black, legs dull red, pale round spots on elytra.

Habitat : A specimen enclosed in Copal.

Small, only three or four lines long, related to *Bl. ciliata*, Thunb., but still smaller, and differs from it in that the thorax is entirely black, margin of same color, abdomen also obscure. Antennæ black, filiform, of the length of half the body, joints distinct, about 27 in number. Body black above, distinctly ciliated on margin; Platypod, and their allies; very many of them seem new, and very few have been known and recognized by us, and not all of these with certainty.

Platypus flavicornis,—brown or dull red, antennæ yellow, elytra puncto-striate, apex produced, bidentate. Plate I. Figs. 14-16.

Bostrichus flavicornis. Fabr. Syst. El., II. p. 384, I. Ent. Syst., 1, 2, p. 384, I.

Scolytes flavicornis. Oliv. Ent., IV. 78; p. 4, I.; Tab. I., f. 1. a. b. ? Does not agree with figure, as elytra are not narrowed at apex. This species inhabits North America, according to Fabricius, in Brazil and Sierra Leone in Africa, in Dr. Schönherr's museum. We have compared our specimen in the Copal with those in Schönherr's museum, and find that they correspond completely, even in what relates to the form of the elytrum, and the striæ, and the striola at the base of the thorax. Elongated, linear, nearly cylindrical, only the elytra are narrow at apex. Antennæ yellow. Head anteriorly oblique-retuse, mandibles not prominent, eyes black. Thorax punctate, here and there very faintly, interstices on the back, denticulated at the apex. Apex of each one prolonged, two pronged at apex. Body below dull red, legs same color, form as in the rest of this genus. Forward tibiæ spread apart, outside scobiform, with four or five transverse costæ, acute.

Tarsi elongated, slender, five jointed in all the legs, first joint longer than the rest, fourth very short, yet it seems so distinct that by right it should not be called only a basal node of the fifth joint.

in each elytrum behind the centre are pale spots, circular, rather translucent. Wings a little dark colored. Body underneath pitch black; legs dull red.

VII. RICANIA EQUESTRIS.

Dark, front light colored, wings very dark, with anterior spots, white, subhyaline, and with a medial ax-shaped fascia. Plate I. Fig. 20.

Habitat : Specimen enclosed in Copal. Expansion of the wings six lines; length of body two. Related to *R. hyalina*, Fabr. (from East Indies); but plainly different in the unspotted outer margin; costa spotted, and medial fascia extending to the thinner margin, though not truly costal and of a different form.

Head short, transverse, vertex dark, front flat, tricarinate. Eyes rather prominent, pale. Body dark, legs pale. Upper wings dark smoky colored, marked with white; in the midst of the wings is a transverse band, abbreviated toward the front, but expanded on the outside, then securiform; inside the rear angle is a round spot, and on the costa itself are some spots: of these the larger is stigmatic-triangular. The lower wings are a light smoky color, several spots toward the base, and two alike, back of the middle, white.

Obs. The upper wings (hemelytra) with numerous longitudinal parallel nervures; many simple, alternately divided or undivided near the margin. The lower wings with fewer nervures, forked at the vertex.

VIII. ASIRACA ALBIPUNCTA.

Darkly testaceous, the head being paler, hemelytra

being dark, margin spotted with white. In the antennæ the joint at the apex is cylindrical, of the length of the thorax.

Habitat : A specimen enclosed in the Copal, unique. Male? Length not quite two lines.

Head small, with a rostrum or proboscis of the length of the breast. Eyes brown, antennæ pale, joints one and two short, the third very large, cylindrical, smooth, bluntly rounded at the apex, of the length of the thorax together with the neck, of about half the diameter of the head. Thorax covered with a dark or smoky colored shell, shining, with short neck of the same color. Body underneath pale, testaceous, the breast, as it seems, being dark colored. Legs pale, slender.

Hemelytra at least twice as long as the abdomen, narrow, smoky colored, nervures not well marked, apical joints terminating in a white point; there are also 8 or 9 spots on the edge of each hemelytrum, quite distinct; furthermore the top of the apex has a thin ruddy margin. The wings are tinged with a paler smoky color, without spots.

IX. CHARIDEA METIS.

Dark wings, the upper with an oblique band near the base, another near the apex, white, the lower ones very short, spotted with white. ♂ ♀ Plate I. Fig. 19. ♂

Habitat : Two specimens, male and female, enclosed in the same piece of Copal. Expansion of the wings 8 lines, length of the body 3 lines. The colors perhaps are changed, yet the species is easily known by its characters.

It seems somewhat allied to the *Ch. columbina* and others; but the rear wings are more abbreviated and the whole appearance is different. The antennæ of the male are more than half as long as the body, pectinated, the radii not close together, short, about 25 in each row of the antennæ. Tongue pale, of the length of the body. Body pale, ringed with dark. Legs slender, pale, of a simple form. The upper wings are quite large, dark, and marked with white. There is an oblique band extending from the base toward the lower corner. Four spots near the costa, in the centre. The band abbreviated in width in front of the apex of the wing. The lower wings are small, acuminate, dark, two white spots partly confluent. Female like to the male, only the antennæ are filiform, and the abdomen a little thicker.

Obs. Some time ago the name of *Charidæ* was given by us to this genus, as both of the Fabrician names *Procris* and *Glaucopis* must be rejected, the first having been before this applied to plants, and the latter to birds.

X. CHELIFER EUCARPUS.

Ch. yellow, the second joint of the arms linear, the third oblong, claw or chela oval, with digits shorter than the carpal. Plate I. Fig. 25.

Habitat : I have examined one specimen enclosed in the Copal, and excellently preserved.

Small, scarcely attaining the length of a French line. Midway, as it were, between *Ch. cancroides* and *cimicoides*, the legs and arms being longer and more slender than in this, but thicker than in the former. It is dis-

tinguished from both by its pale color and in the proportion of joints in the arms. With *Ch. acaroides* it agrees in color, but differs altogether in the shape of the chelæ, and in the third oval joint of the arms, shortened very little, angled as in that. The entire insect is pale yellow, thorax and fore legs being deeper colored. Body oblong, scarcely hairy. Thorax of two sections, abdomen of ten. Fore feet or arms, so called, much longer than the body, yellow; first joint short, rather conical; second nearly three times as long as the one before, linear, nearly cylindrical, not thinning out toward the base; the third scarcely shorter than second, oblong; chela twice as thick as the preceding joints, and plainly longer than the second joint, oval, less sharp than in related species, digits equal, but clearly shorter than the carpus. In *Ch. cancroides*, digits of the length of the carpi. True feet a little shorter, paler, less elongated than in *Ch. cancroides*, but more slender and longer than *Ch. cimicoides*.*

* Species of this class very much need related species for a more accurate comparison.

Ch. cancroides. Legs more slender, arms nearly twice as long as the body, all the joints excepting the first being narrower and more elongated than in *Ch. cimicoides*. First joint short, obovate, tumid above, second almost four times as long as the one before, obconical, narrow at the base, the third somewhat shorter than the second, plainly obconical, narrow at the base. Chela nearly twice as thick as the preceding joints, but clearly longer, thin toward the apex, digits being equal, sublinear-curved, in no way shorter than the carpus.

Ch. cimicoides. More often smaller, more hairy, legs shorter,

If the claws of *Ch. cancroides* should be said to suggest the claws of *Astacus fluviatilis*, the claws of this species may be very well compared with the claws of *Astacus marinus*, although the digits are less thin.

EXPLANATION OF FIGURES.

The figures are all enlarged, the adjacent line showing natural size.

Plate I. :—

- Fig. 1. *Ripidius megalophus*, seen from behind.
- Fig. 2. Same underneath, antennæ bent back.
- Fig. 3. Head of same with antennæ.
- Fig. 4. Posterior leg.
- Fig. 5. *Ripidius pyrrholophus*.
- Fig. 6. Elytron.
- Fig. 7. Wing.
- Fig. 8. Posterior leg.

arms a little longer than the body, all the joints short, thick; first slightly ovate, swelling above, so that in a certain position it appears nearly angular, second nearly twice as long as the former, thick, almost oblong, third shorter than the second, obovate, thick in the middle, chela thicker, nearly ovate, somewhat inflated at the base, narrow at apex, digits equal, shorter than the carpus.

Ch. acaroides (Lin. Fabr.—*Ch. americanus*. De Geer, Tome. VII. Plate 42, Figs. 1-5. Page 353). Differs from the preceding ones in that the third joint of the arm is angular, body cylindriciform, and also in color and size.

[Obs. Roesel (Vol. III. Plate LXIV.) figured the joints of *Ch. cancroides*, but made the middle ones of the arm too narrow toward the base, and the joints of the chelæ unequal. De Geer's figures (Vol. VII. Plate 9, Figs. 14, 15) are better in this respect, and the figures in Svensk's zoölogical work are sufficiently good.

- Figs. 9 and 10. *Pausus cruciatus*.
Fig. 11. Antenna.
Fig. 12. *Articerus armatus*.
Figs. 13 and 14. *Platypus flavicornis*, Fabr. ?
Fig. 15. Anterior leg.
Fig. 16. Posterior leg.
Fig. 17. *Cerambyx dichropterus*.
Fig. 18. *Prionopus acanthomerus*.
Fig. 19. *Charidea metis*.
Fig. 20. *Ricania equestris*.
Fig. 21. *Palmon bellator*.
Fig. 22. Head of same with antennæ.
Fig. 23. Femur of same, rear pair.
Fig. 24. Head of *Palmon clavellatus* with antennæ.
Fig. 25. *Chelifer eucarpus*.

II.

JOHN.

"NATURAL HISTORY OF AMBER," BY J. F. JOHN.*

COPAL.

The antiquity of the knowledge of Copal cannot be given with accuracy, but it is very probable that it became known soon after the discovery of amber, was supposed to be a species of amber, and was designated by Pliny and other classic writers by the name of *Succinum africanum* and *S. indicum*.†

Geoffroy is of the opinion that Copal was brought to our notice when the New World was discovered, but this seems to me unlikely.

Sendell‡ describes it under the name of *Succinum indicum*, or *Pseudosuccinum*, as a substance related to amber.

* In two parts, published by Th. F. Thirlart (Cologne, 1816), Part II., p. 73.

† There is no doubt that among the ancients various resinous substances were supposed to be amber, if it be remembered that they named localities in which amber was said to occur, where there were only those trees to be found which produced other resins, and which were perhaps supposed to be amber-bearing trees. And again, many resins are supposed to be Copal. It is stated by Piso, that the natives in America call all clear resins and gums by the name of Copal (Copall).

‡ De Succino indico Pseudosuccino ad virum nobil. J. Ph. Breynium. Elbing 1721; in J. Ph. Breynii Epistolade melonibus petrifactis. Lips. 1722.

Its similarity to amber, and the fact that at first it was obtained from the low lands on the Guinea coast, in the province of Benin, were doubtless the causes of this mistake. For these reasons many mineralogists classed it among the minerals. Lehmann * seems to have been the first to do this. His example was followed by the great botanist Linnæus, who, in his account of fossil resins, gives a very good description of Copal, remarking at the end of it, that care should be taken to distinguish this fossil resin from the exudation of the Copal tree.†

Other authors, for instance Macquer ‡ and Spielmann§, considered it to be a fatty oil, changed and hardened by some acid. Scopoli followed Lehmann's example.¶ He classed it among the bitumens, dividing it into Succinum electricum and Succ. Copal. Wasserberg did the same.**

While these varying opinions were held concerning the origin and nature of this substance, which was then coming into general use because of the beautiful varnish to be made from it, certain learned travellers discovered that Copal was an air-dried gum †† produced by a tree native to North America. It was called Succinum vegetable (to distinguish it from Succinum electricum,

* *Chymische Versuche mit dem Copal. Neues Chem. Arch. B. C. Entw. einer Mineralog., p. 66.—Mem. de Berlin. 1758, p. 34.*

† *Mineralreich, übers. von Gmelin. B. 2., p. 433.*

‡ *Wörterbuch, Oel.*

§ *Institut. Mater. med.*

¶ *Princip. mineral. systemat. et pract.*

** *Fr. de Wasserberg, Institut. chemiæ, T. III., p. 108. Vindob. 1780.*

†† The natives used it in sacrificing to their gods.

then supposed to be a fossil) and Succinum Copal. Pomet* states that Levant Copal (African or Oriental Copal) exudes from the trunks of certain trees, the leaves of which resemble the leaves of nut trees, its fruits being like cucumbers.

Condamine† remarks that the Indians use it for lights, in place of tallow.

Hernandez‡ states that there are eight kinds of Copal trees, the principal one of which is called Quohill, having leaves like our oak trees, and being similar to these in size.

Although many chemists had experimented with Copal, its true nature was always more or less doubtful to them. Sometimes they thought to have discovered that Copal had certain similarities with amber or with resins or gums, but after all there still remained many points in which these substances were very dissimilar. It is for this reason that in hand-books of Pharmacy and the *Materia Medica* we find Copal classed among gums, resins, or gum resins, &c.; and because the African Copal is found in the sand, and the North American Copal is obtained from trees, many authors, including even Linnæus, held that they were two different substances, one of which was a mineral and the other a vegetable product.

In the year 1776 a treatise was written by Bloch and

* *Hist. des drogues.*

† *Journey to the interior of South America. Mag. VI., p. 49.*

Hist. Mexicana.—Beschäft. der Berl. Gesell. B. 2, p. 99. 1776.

Klaproth, on the different varieties of true Copal, with intent to prove the fact of their vegetable origin. The former wrote the part descriptive of the natural history, and the latter, the chemical part.* From his experiments Klaproth came to the conclusion that Copal could not belong to the mineral kingdom, but was a resin originating from trees. Under dry distillation, eight ounces of it gave one-half ounce of a clear yellow subtile oil, soluble in alcohol, and three drachms of a clear yellow phlegm; being heated more strongly, five ounces of dark oil, insoluble in spirits of wine, were distilled. There remained in the retort one ounce of residue, the ash of which was somewhat sensitive to the magnet. Pan Copal gave similar results, excepting that a red pitchy matter was sublimed, and that it gave a little more oil, and less earthy residue in the ash. The results of Lehmann's experiments agreed with these, but Geoffroy† obtained an acid phlegm, which Klaproth attributed to the animal matter (enclosed insects, &c.).

He found that Copal was soluble in all artificial naphthas, making fine varnishes with them. The strongest alcohol only partly dissolved it, but when Venetian turpentine or camphor was added, a complete solution took place, and the fluid could then be used as a varnish. Spirits of wine showed less action on copaiva balsam. Ether absorbs traces only of the part insoluble in spirits

* Proceedings of Berlin Soc. of Naturforschende Freunde. B. 2, p. 91 to 197. Berlin, 1776.

† Materia Medica. T. 2.

of wine. It cannot be dissolved in oil of turpentine, whether the latter has been made from Venetian turpentine or ordinary turpentine, for which reason Klaproth thinks that Lehmann was mistaken when he asserted the contrary. Other ether oils, *i.e.*, oil of lavender, and oil of rosemary, dissolve it immediately on application of heat, and these solutions may be mixed with spirits of wine, in which respect they differ from the solution in ether, as the addition of spirits of wine to that precipitates a notable quality of Copal. From one drachm of Copal there remained only two grains of a turpentine-like residue. Certain empyreumatic oils, such as benzol and oil of Copal, dissolved it at once, while others, such as oil of amber, and petroleum, had no effect upon it. In fatty oils it was also insoluble; these even precipitated it in form of a sticky mass from its solution in ether oils.

Only when it had been heated until it began to decompose was it soluble in oil of turpentine and fatty oils.

Concentrated sulphuric acid and fuming nitric acid dissolved it. Carbonates of the alkalies converted it into a pasty mass, on application of heat, but caustic alkalies dissolved it. It appears, on the whole, as a result of Klaproth's investigations, that Copal is neither a gum, a resin, nor a gum resin possessing the characteristics of both. In the most recent text-books of chemistry, it is generally classed under the head of vegetable resins as a peculiar substance.

II.

EXTERNAL AND PHYSICAL CHARACTERISTICS.

ORIGIN.

Color. Passes from colorless through wine yellow into brown yellow. Bloch* mentions also green, red, purple and violet, but in this it is doubtless similar to amber, these varieties indicating either an unhealthy condition of the Copal tree, or being due to the heterogeneous materials contained in the Copal.

Outer form. Irregular, ball-like, in drop form, &c.

Fracture. Conchoidal.

Lustre. Brilliant, glass-like.

Transparency. Entirely transparent and translucent. There are frequently found intrusive substances, plants, insects, sand, &c., enclosed in it, and Bloch mentions a case where, in a large quantity, a fatty liquid was found, which gave a dark precipitate with solution of iron. This occurrence of various substances in Copal has long been noticed by naturalists, who, from an analogous property of amber, wished to prove the mineral origin of the latter; but some of them state that they find nothing of the kind in Copal.

Hardness. Soft.

Elasticity. Somewhat elastic. It may easily be broken and reduced to powder.

Smell. On being rubbed, emits a resinous but peculiar odor.

* Beschäft. der Berlin. Gesell. Nat. Freunde. B. 2, p. 194. 1776.

Taste. None.

Specific Gravity. 1.050 to 1.100.

Origin. It exudes from a North American tree, which is believed to be the *Rhus copallinum* * of Linnæus. It is, however, probable that this tree may be found in other parts of the world, and learned travellers say that the best kinds come from Spanish America. As the Guinea Copal is found in the sand on the shore at Benin, it seems likely that this species of *Rhus* formerly grew in Africa, and had some similarity with it, just as the case has been with the amber trees in Prussia.

III.

CHEMICAL QUALITIES.

Copal undergoes no change in the atmosphere.

Behavior when heated. At 40° R. it begins to soften, at a higher temperature (60° R.) it swells, and bubbles before melting. It remains liquid until entirely carbonized. If Copal is allowed to remain molten for a while, it darkens, and when cooled, becomes a brown-red, hard, brilliant, transparent mass. Held to the flame, it burns, melts, swells up, bubbles, and then burns with a lively flame.

Distillation.

On distillation pure Copal gives one per cent. to one-half per cent. water, which smells of acetic acid,—the

* The name Copal is of American origin, being used by the natives to designate a variety of trees. Pan Copal is the name given to the best kind of the true Copal.

ordinary gases of vegetable bodies,—and a large quantity of a clear greenish yellow oil, which almost amounts to the weight of the distilled Copal. On adding water copiously to the aqueous solution, which reddened blue litmus paper, I obtained a small residue which, being moistened with natron water, and freed from the insoluble oily parts, was not precipitated by sesquioxide of iron.

As various chemists have stated that Copal gave no acid on being distilled, I repeated this operation, with pure, clear pieces of Copal, entirely free from enclosed matter, and obtained the same result. These chemists probably did not employ re-agents of sufficient purity or delicacy in testing for the minute quantity of acetic acid.*

The carbonized matter remaining in the retort, which amounts to about eight per cent. of the whole, is hard, brittle, and colored black and blue. The blue color is an indication of a small amount of nitrogen contained in the

* Others say that on distilling Copal they obtained acid of amber. If this really has been done lately, it shows that the Copal was mixed with amber. Formerly it was asserted that ambra as well as stone coal gave off acids; but this assertion was probably based on analogy, because ambra was thought to be a species of Succinum. And, moreover, it is not strange if some anthracite (stone coal) or bituminous coal did yield acid of amber, on being distilled, if it be remembered that amber often occurs in them.

Hoffman mentions that he obtained an acid salt from stone coal (Obs. Chym., p. 204).

Hurella did not obtain a salt from it, but did obtain a urinary fluid (Chym. Vera. u. Erfahr. St 1, p. 69).

Cartheuser obtained an acid vapor.

Copal. It is probable that on distilling a somewhat larger amount some traces of ammonia would be found at the close of the operation; this frequently happens in the distillation of vegetable matter, after the substance has become carbonized.

On reducing the carbonized matter from two drachms of Copal to ashes, the ash weighed 1-10 grain, and was reddish; it contained traces of carbonate of potash and lime, and of phosphate of lime and oxide of iron.

BEHAVIOR IN WATER.

Cold water has no effect on it; after long boiling in water the Copal gives off traces of a bitter matter, and then undergoes no further change, beyond becoming somewhat soft.

BEHAVIOR IN SPIRITS OF WINE.

Alcohol of 90°, and, still more, absolute alcohol, dissolves more than half of the Copal, making a good varnish of a pale yellow color. If the solutions are warmed and concentrated, they give a precipitate when cold, becoming cloudy at first, and then clearing, as the precipitate falls to the bottom.

BEHAVIOR IN ETHER.

Sulphuric ether, cold or warm, dissolves Copal more rapidly than alcohol, leaving only a small percentage of insoluble residue.

This solution makes a good varnish, which is especially adapted to the lacquering of metallic instruments. It should be used with application of heat.

BEHAVIOR IN ETHER OILS.

The ether oils differ in their action on Copal.

Oil of lavender and of rosemary dissolve Copal completely on being heated; at least I could find no trace of residue on the filter through which the solution had passed. These oils are generally used with camphor, in dissolving Copal, alcohol then being added, to make a varnish.

Oil of turpentine dissolves Copal only after having been digested with it for days, or even weeks, at a temperature of from 20° to 80° R. It makes a very good varnish. On one occasion, on adding to such a solution a quantity of oil of turpentine, I found that the entire amount of Copal in solution separated as a coagulated mass. But it dissolved again. Pure oil of turpentine, free from resin, some of which had dissolved Spanish resin immediately, being digested quickly with Copal, had so little effect on it, that it did not even dissolve the resinous parts, which alcohol had easily done.*

The action of oil of turpentine on melted Copal (which thereby has become somewhat decomposed), and on which the manufacture of varnish is based, is already well-known.

Rectified petroleum dissolves hardly a trace of Copal, or of its resins; when placed in it they sink to the bottom as a matted mass.

*Some chemists recommend that the oil of turpentine be used in vapor form for dissolving Copal, but this method has no advantage. Resins which are soluble in ether or spirituous menstruum do not require any vapor.

ACTION OF THE FAT ACIDS.

Clean and unaltered Copal is not dissolved by them; a melting of the Copal is necessary before it admits of the first decomposition. On this property of Copal is based the preparation of oily Copal varnish, concerning which there are almost as many descriptions as there have been chemists employed in the investigation of Copal. For instance :

Blindheim's Copal varnish for use on metal, in place of tinning, in *Crell's Chem. Ann.*, 1784, Vol. II., p. 5.

Westrumb, on solution of Copal in alcohol and camphor, in *Retzius' Introduc. to Study of Medicine*, p. 40, Leipzig, 1786.

Watin, on the uses of Copal varnish.

Ludolf, *Introduction to Chemistry*.

Klaproth, trans. Berlin. *Gesell. Natur. Freunde*, Vol. II., p. 191, 1776.

Bloch, *Lectures*, II., p. 359.

Scheldrake, in *Thomson's Chemistry*, Vol. IV., p. 149.

Van Mons and Demmenie's *Investigations in Journal of Chemistry*, III., p. 218.

Thomson, *Chemistry*, Vol. V., p. 704.

BEHAVIOR WITH ALKALIES.

When carbonates of the alkalies are boiled with powdered Copal, they dissolve somewhat of the resin which is soluble in alcohol; this is precipitated by acids. The greater part of the Copal floats on the liquid as a spongy mass.

BEHAVIOR WITH ACIDS.

The behavior of Copal with acids is very similar to that of amber. Concentrated sulphuric acid dissolves it, making a brown-red solution, and nitric acid acts upon Copal exactly as it does on amber.

ANALYSIS OF COPAL.

(a) Fifty grains of powdered Copal were digested repeatedly with alcohol of 100°, until nothing more dissolved. The residue, which was white, granular, spongy and opaque, weighed 15 grains.

(b) The alcohol solutions, which were straw yellow in color, became milky on addition of water, which precipitated the greater part of the resin in a compact, viscid mass. The milky liquid was heated to expel the alcohol, and filtered to free it from resin. This resin behaves very much like Copal: it swells on being heated, is easily soluble in alcohol, but scarcely at all in oil of turpentine.

(c) The clear, colorless filtrate from (b) reddened litmus paper, it precipitated the silver from solution of nitrate of silver, and lead from solution of acetate of lead, both the precipitates being in form of white powder, somewhat flocculent. With solution of iron, it also gave a white precipitate, which was unaltered on being exposed to the air.

When diluted and gently warmed there was no trace of crystallization, but it was converted to a shiny, varnish-like, clear yellow coating on being dried. This was readily soluble in water and alcohol. It had a bitter, salty, acid taste (also somewhat astringent, I thought),

and is so similar to the balsamic bitter substance of amber, that as yet I know of no definite way of defining the difference between them.

I neutralized the acid in the dissolved balsamic substance with soda, until the solution was faintly acid, and added to the clarified fluid some oxidized chloride of iron,—a brown precipitate at once appeared, similar to that produced by amber solution, after being treated with soda.

This acid seems to be a true amberacid. As, however, it is possible that its properties may show it to be an acid peculiar to itself, I will call it provisionally by the name of Copal acid. These properties could be ascertained only by the examination of a large quantity of the acid, which might perhaps be separated from the balsamic bitter material by means of sulphuric ether.

The composition of the bitter extract is, aside from the bitter balsamic matter, Copal acid and traces of alkaline salts.

(d) I now turn to the decomposition of the Copal residue which was insoluble in absolute alcohol (a). These 15 grains were placed in two drachms of sulphuric ether. The powder immediately swelled and formed a spongy mass. With the idea of converting it gradually into a clear solution, I exposed it to a gentle heat, but with no result, except that a separation of the swollen matter, insoluble in ether, took place, so that a great part of the ether fluid could be poured off. The ether had dissolved one-half of the 15 grains, and, after being diluted, with

access of air, left a white, viscid, somewhat sticky membrane, which covered the sides of the vessel, and from which it could easily be rolled and separated.

This resinous matter is insoluble in either ordinary or absolute alcohol, and is precipitated by these liquids from its solution in ether. It seems to be the same that falls from hot alcoholic solutions when they are cooled.

Alcohol separated 3 grains of resin from the ether solution.

(e) I now tried to separate the transparent mass by filtration. It was saturated with ether, as described in (d). This could in no wise be done, as the intimate union between the ether and the insoluble material, as well as the volatility of the ether during its filtration, made it impossible. This mass was not soluble in a larger quantity of ether. The few properties which I have detected in this substance are sufficient to allow us to regard it as a peculiar constituent of plants, which may be called copalin. I intend to examine the properties of this material more closely hereafter.

These analyses have unveiled the enigmatical character of Copal, it being possible to decide with more certainty concerning the various means of dissolving it, when we desire to use it in the arts.

We see that 100 parts of clear wine-yellow Copal (almost colorless in thin pieces) contain:

Resin, soluble in alcohol, ...	75.00
Peculiar resin, insoluble in alcohol, but soluble in ether, ...	8.90

Bitter, balsamic extract, soluble in water and alcohol, ...	0.50
Copal acid, which seems to be identical with amber acid, and water, about .	0.50
Copalin, a substance insoluble in ether and alcohol, ...	15.00
Compounds of Copal with potash and lime, occurring as acid salts in Co- pal. Phosphate of lime and a com- pound of iron and Copal, ...	00.10 to 0.15
	100.00

REMARKS.

The outer similarity, and still more the similarity of the composition of Copal and amber, not only assures us that they are both vegetable substances, but that they are to be regarded as bodies between which there is the most intimate relation. If in former times care had been taken to examine the inner nature of both substances and to compare them, this result would have been attained long ago, and hundreds of authors who have with labor written huge books on amber would have been relieved of their pains, for these two substances would have been placed in their true position in natural history.

Both contain nitrogen as a component part. The resemblance between them would amount to an identity, if further researches would enable us to prove that the acid of Copal was the same as that of amber. Because of its minute quantity, this acid cannot be obtained unaltered

during the distillation of Copal. The resin of Copal, which is soluble in cold and warm alcohol, has great resemblance to the ordinary resins.* Like these, it is precipitated by water from spirituous and ether solutions, in form of a white powder and a compact mass. In oil of turpentine it is soluble only when it contains turpentine resin.

It is also insoluble in rectified petroleum. On being warmed it swells and bubbles before melting, and then becomes darker. It is dry, hard, and brittle. The resin of Copal, which is insoluble in alcohol, dissolves both in cold and warm ether. On being separated from this, it is viscid and soft, but, being dried, it becomes hard and brittle. Alcohol precipitates it from the ether solution in form of a white powder. In oil of turpentine, it dissolves only on being heated, if this contains thick turpentine resin. The other ether oils, such as oil of lavender or rosemary, dissolve it. Copal is insoluble in alcohol, and remains in it during digestion as a white powder.

Oil of turpentine and petroleum have no effect on it. It does not swell in water.

Oil of lavender dissolves it, if Copal be in the solution, for nothing remains on filtering the liquid. But the copalin mass, united with ether, did not fully dissolve in oil of lavender, after long digestion.

Ether makes no solution with copalin; but there must

* Alcohol of only 80° dissolves only part of the resin, and alcohol still more dilute has no effect on it. Hence come the ridiculous tales about the difficulty of dissolving Copal in alcohol.

be great affinity between them, for the ether penetrates it and increases its volume one-hundredfold, apparently making a gluten, which may be drawn out between the fingers into very elastic threads.

III.

COOKE.

“*TRACHYLOBIUM MOZAMBICENSE*, PETERS.”*

Habitat: Eastern Africa.

Bombay anime, E. Indian anime, Gum anime.

The resin known in commerce as Bombay anime, Indian anime, or Gum anime, is undoubtedly derived wholly from Zanzibar, and has been referred to the above tree as its botanical source. The latest collected information on this subject was communicated in a note to the *Gardener's Chronicle* (1865), of which the following is the substance :

“Lieut. Col. Playfair, H. M. Consul at Zanzibar, has recently transmitted to the Kew Museum, in answer to a request of the late Sir W. J. Hooker, some fine specimens of the bark of a tree, with the resin *in situ*, together with fruits of the same plant, and various specimens of collected resin. On the bark the resin is thickly formed in large irregular masses: the external appearance is of a dusky gray, but its fracture is of a clear, shining yellow.”

The tree yielding this resin, Col. Playfair thinks, is the true Copal of the mainland of Zanzibar; this is an announcement of some importance, in support of which we

* Published in Report on Gums, Resins, Oleo-Resins, and Resinous Products in the India Museum, or Produced in India, by Dr. M. C. Cooke (London, India Museum, 1874), pp. 98, 99, 100, 101, 102, 103.

anxiously look for further information. Believing, however, the fruits to be what Col. Playfair sends them for, viz, the fruits of the Zanzibar Copal tree, there seems little doubt, on comparing them with specimens in the Kew Herbarium, that they belong to *Hymenaea Mossambicensis*, Kl.

Col. Playfair says, in his report to the foreign office in reply to Earl Russel's enquiries respecting the supply of resin, that the value of Copal exported from Zanzibar amounted during the years 1863-4 to \$163,353, the average price being about six pounds for one Austrian dollar. These sums were made up as follows :

United Kingdom	\$30,030
British India	50,044
Kertch	500
United States of America	5,000
Hamburg	30,000
Italy	2,339

If, therefore, a revenue like this is derived from the resin of this particular plant in Zanzibar, it would be well if Madagascar, where the plant likewise grows, could open up a traffic in the same commodity. Capt. Burton says of the Zanzibar Copal tree, that out of its trunk "canoes have been formed sixty feet long, and that a single tree has sufficed for the keelson of a brig; the average size, however, is about one-half that height, with from five to six feet girth near the ground. The trunk is dotted with exudations of raw gum, which is found scattered in bits about the base." The resin is also found in a semi-fossil

state, sometimes in places overflowed by the high-tides, or when sinking piles for huts, etc. At Zanzibar the resin is sifted and cleansed from impurities before it finds its way into the hands of the foreign merchants; after this it is again cleansed by washing in chemical solutions of various degrees of strength, care being taken to thoroughly purify, but, at the same time, not to injure the so-called "goose-skin," or the impress of the sand.

All parts of the plants of the Copal-yielding species of *Hymenaea* are highly charged with resin, and in none is it more apparent than in the fruits of the species sent home by Col. Playfair. The little warts or verrucosities on the surface of these pods are lumps of clear colorless resin, simply covered with the thin epidermis or cuticle of the pod. To such an extent are these pods charged with resin, that they burn freely upon the least approach of flame. The same property is observable in the pods of the South American species, *Hymenaea courbaril*, from the trunk of which exude very large quantities of resin; but this pod, being larger and more ligneous, and the resin distributed in small ducts all over the surface without penetrating the substance of the pod, does not burn so readily, nor is the quantity of resin so large. The outside of the pods much resembles in appearance the sand-fretted surface of the resin.—Gardener's Chronicle, Dec. 16, 1865.

In a letter from Zanzibar, dated 1869, Dr. Kirk writes to Dr. Hooker:—"In the dense forest I was struck with the immense number and size of the Copal trees, far ex-

ceeding anything that I had before imagined. In no instance did I see the soft juice flowing; when found on the tree it was invariably hard. I send a fine specimen removed from the living tree; it will show you that now large masses, equalling in size the fossils, are still produced, and full of insects, as were those of the ancient forests. In the dense jungles, where the trees are found the largest, there is no under-grass to catch fire and to destroy the fallen trunks; when a tree dies it rots until eaten by white ants; it falls piece by piece on the ground; any resinous masses would thus be preserved.

“Struck by the number of these trees, I commenced turning up the sandy soil to the depth of ten inches, when I soon found small pieces of animi, but not of the modern sort. There was no Copal tree in the place where I dug: and the resin had laid there, it may be, for centuries. This led me to minutely examine the outer skin, and I found that Copal when dug up has no trace of the goose-skin upon it. I am now satisfied that this is due to a change in the surface of the mass after exposure, when to a certain depth an oxidation takes place, or it may be a molecular change, rendering the skin more brittle than the inner mass. When treated with a solution of caustic soda, this brittle crust softens, and, on drying, cracks to the full depth to which the change has taken place. After drying in the sun, the friable crust may be removed with a hair-brush, and then, for the first time, we see the goose-skin, characteristic of good or fossil animi (Journal Linnean Soc.).

"When cleaning Copal, it may be said that each merchant throws away as much as thirty pounds daily of this dusty resin brushed off the Copal, and this they call sand; but it is genuine resin, and, I suspect, of value, at least worth more than being cast into the sea, as is here done."

The remarks of Captain Burton in his "Lake Regions" throw considerable light on the history of Zanzibar Copal or animi. He writes:

The Copal tree is called by the Arabs Shajar el Sandarús, from the Hindoostani chhandarus; by the Wasawahili msandarusi; and by the Wazaramo and other maritime races mnángú. The tree still lingers on the island and mainland of Zanzibar. It was observed at Monibosah, Saadani, Muhonyera, and Mzegero of Uzaramo, and was heard of at Bagamoyo, Mbuamaji, and Kilwa. It is by no means, as some have supposed, a shrubby thorn; its towering bole has formed canoes sixty feet long, and a single tree has sufficed for the keelson of a brig. The average size, however, is about one-half that height, with from three to six feet girth near the ground; the bark is smooth, the lower branches are often within reach of a man's hand, and the tree frequently emerges from a natural ring fence of dense vegetation. The trunk is of a yellow whitish tinge, rendering the tree conspicuous amid the dark African jungle growths; it is dotted with exudations of raw gum, which is found scattered in bits about the base; and it is infested with ants, especially by a long ginger-colored and semi-transparent

variety, called by the people maji-móto, or "boiling water," from its fiery bite.

The Copal wood is yellow tinted, the saw collects from it large flakes; when dried and polished, it darkens to a honey-brown, and being well veined it is used for the panels of doors.

The small and pliable branches, freshly cut, form favorite "bakur," the Kur bajo bastinadoing instrument of these regions; after long keeping they become brittle. The modern habitat of the tree is the alluvial sea-plain and the anciently raised beach; though extending over the crest of the latter formation, it ceases to be found at any distance beyond the landward counterslope, and it is unknown in the interior.

The gum Copal is called by the Arabs and Hindoos sandarús, by the Wasawahili msandarusi, and by the Wanyam wezi, who employ it, like the people of Mexico and Yucatan, as incense in incantations and medicinings, sirokko and mámináugu.

This semi-fossil is not "washed out by streams and torrents," but "crowded" or dug up by the coast clans and the barbarians of the maritime region.

In places it is found when sinking piles for huts, and at times it is picked up in spots overflowed by the high tides. The East African seaboard, from Ras Gomani in S. lat. 3° to Ras Delgado in 10° 41', with a medium depth of 30 miles, may be indeed called the "Copal Coast;" every part supplies more or less the gum of commerce. Even a section of this line from the mouth of

the Pangani and to Ngao (Monghou) would, if properly exploited, suffice to supply all our present wants.

The Arabs and Africans divide the gum into two different kinds. The raw Copal (Copal vert of the French market) is called (sandarusiza) miti, "tree Copal," or chakazi, corrupted by the Zanzibar merchant to "jack-ass Copal." This chakazi is either picked from the tree or is found as in the island of Zanzibar, shallowly embedded in the loose soil, where it has not remained long enough to attain the phase of bitumenization. To the eye it is smoky or clouded inside; it feels soft, it becomes like putty when exposed to the action of alcohol, and it viscidizes in the solution used for washing the true Copal. Little valued in European technology, it is exported to Bombay, where it is converted into an inferior varnish for carriages and palanquins, and to China, where the people have discovered, it is said, for utilizing it, a process which, like the manufacture of rice paper and India ink, they keep secret. The price of chakazi varies from four to nine dollars per frasilah.

The true or ripe Copal, properly called sandarusi, is the product of vast extinct forests, overthrown in former ages either by some violent action of the elements or exuded from the roots of the tree by an abnormal action which exhausted and destroyed it. The gum buried at depths beyond atmospheric influence has, like amber and similar gum resins, been bitumenized in all its purity, the volatile principles being fixed by moisture and by the exclusion of external air.

That it is the produce of a tree is proved by the discovery of pieces of gum embedded in a touch-wood which crumbles under the fingers; the "goose-skin," which is the impress of sand or gravel, shows that it was buried in a soft state; and the bees, flies, gnats, and other insects which are sometimes found in it delicately preserved, seem to disprove a remote geologic antiquity. At the end of the rains it is usually carried ungarbled to Zanzibar. When garbled on the coast it acquires an additional value of one dollar per frasilah. The Banyan embarks it on board his own boat, or pays a freight varying from two to four annas, and the usher or government tax is six annas per frasilah, with one-half anna for charity.

About eight annas per frasilah are deducted for tare and tret.

At Zanzibar, after being sifted and freed from heterogeneous matter, it is sent by the Banyan retailer to the Indian market or sold to the foreign merchant. It is then washed in solutions of various strengths; the lye is supposed to be composed of soda and other agents for softening the water; its proportions, however, are kept a profound secret. European technologists have, it is said, vainly proposed theoretical methods for the delicate part of the operation, which is to clean the goose-skin of dirt. The Americans exported the gum uncleaned, because the operation is better performed at Salem.

Of late years they have begun to prepare it at Zanzibar, like the Hamburg traders. When taken from the

solution, in which 20 to 37 per cent. is lost, the gum is washed, sun dried for some hours, and cleaned with a hard brush, which must not, however, injure the goose-skin; the dark "eyes," where the dirt has sunk deep, are also picked out with an iron tool. It is then carefully garbled with due regard to color and size.

There are many tints and peculiarities known only to those whose interests compel them to study and observe Copal, which, like cotton and cashmere shawls, requires years of experience. As a rule, the clear and semi-transparent is the best; then follow the numerous and almost imperceptible varieties of dull white, lemon color, amber yellow, rhubarb yellow, bright red, and dull red. Some specimens of this vegetable fossil appear by their dirty and blackened hue to have been subjected to the influence of fire; others, again, are remarkable for a tender grass-green color. According to some authorities, the gum, when long kept, has been observed to change its tinge. The sizes are fine, medium, and large, with many subdivisions; the pieces vary from the dimensions of small pebbles to two or three ounces. They have been known to weigh five pounds, and it is said at Salem a piece of thirty-five pounds is shown. Lastly, the gum is thrown broadcast into boxes and exported from the island.

The Hamburg merchants keep European coopers, who put together the cases, whose material is sent out to them.

It is almost impossible to average the export of Copal from Zanzibar. According to the late Lieut.-Col. Ha-

merton, it varies from 800,000 to 1,200,000 pounds per annum, of which Hamburg absorbs 150,000 pounds, and Bombay two lacs worth. The refuse Copal used formerly to reach India as "packing," being deemed of no value in commerce; of late years the scarcity of the supply has rendered merchants more careful. The price also is subject to incessant fluctuations, and during the last few years it has increased from \$4.50 to a maximum of \$12 per frasilah.

According to the Arabs, the redder the soil the better is the Copal. The superficies of the Copal country is generally a thin coat of white sand covering a dark and fertilizing humus, the vestiges of decayed vegetation, which varies from a few inches to one and a half feet in depth. In the island of Zanzibar, which produces only the chakazi or raw Copal, the sub-soil is a stiff blue clay, the raised sea-beach and the ancient habitat of the cocoa.

It becomes greasy and adhesive, clogging the hoe in its lower bed, where it is dotted with blood-red fragments of ochreish earth, proving the presence of oxidizing and chalybeate efficients, and with a fibrous bright red matter, apparently decayed cocoa roots. At a depth of from two to three feet, water oozes from the greasy walls of the pit.

When digging through these foundations the gum Copal occurs in the vegetable soil over-lying the clayey sub-soil.

A visit to the little port of Saadani afforded different results. After crossing three miles of alluvial and mari-

time plain, covered with a rank vegetation of spear-grass and low thorns, with occasional mimosas and tall hyphenas, which have supplanted the cocoa, the traveller finds a few scattered specimens of the living tree, and pits dotting the ground. The diggers, however, generally advance another mile to a distinctly formed sea-beach, marked with lateral bands of quartzose and water-rolled pebbles, and swelling gradually to 150 feet from the alluvial plain. The thin but rich vegetable covering supports a luxuriant thicket, the sub-soil is red and sandy, and the color darkens as the excavation deepens.

After three feet, fibrous matter appears, and below this Copal, dusty and comminuted, is blended with the red, ochreish earth.

The guides assert that they have not hit upon the sub-soil of blue clay, but they never dig lower than a man's waist, and the pits are seldom more than two feet in depth. Though the soil is red, the Copal of Saadani is little prized; being of a dull white color it is usually designated as *chakazi*.

On the line inland from Bagamoyo and Raole the Copal tree was observed at rare intervals in the forest, and the pits extended as far as Muhonyera, about forty miles in direct distance from the coast. The produce of this country, though not first-rate, is considered far superior to that about Saadani. Good Copal is dug up in the vicinity of Mbuamaji, and the diggings are said to extend six marches inland. The Wadenkereko, a wild tribe mixed with and stretching southwards of the Wazaramo

at a distance of two days' journey from the sea, supply a mixed quality, more often white than red. The best gums are procured from Hunda and its adjacent districts. Frequent feuds with the citizens deter the wild people from venturing out of their jungles, and thus the Banyans of Mbuamaji find two small dhows sufficient for the carriage of their stores. At that port the price of Copal varies from \$2.50 to \$3 per frasilah. The banks of the Rufji River, especially the northern district of Wande, supply the finest and best of Copal; it is dug up by the Wawande tribe, who either carry it to Kikunya and other ports, or sell it to travelling hucksters. The price in loco is \$1.50 to \$2 per frasilah; on the coast it rises to \$3.50. At all these places the tariff varies with the Bombay market, and in 1858 little was exported, owing to the enlistment of "free laborers."

In the vicinity of Kilwa, for two marches inland, Copal is dug up by the Mandandu and other tribes; owing to the facility of carriage and the comparative safety of the country, it is somewhat dearer than that purchased on the banks of the Rufji.

The Copal of Ngao (Monghou) and the Lindi Creek is much cheaper than at Kilwa; the produce, however, is variable in quality, being mostly of a dull white chakazi.

Like that of East African produce generally, the exploitation of Copal is careless and desultory. The diggers are of the lowest classes, and hands are much wanted.

Near the seaboard it is worked by the fringe of Moslem negroids, called Wamrima, or coast clans; each gang

has its own mtu inku or akidaao (Mucaddum-headman), who by distributing the stock contrives to gain more and labor less than his followers. In the interior it is exploited by the Washenzi, or heathen, who work independently of one another. When there is no blood feud they carry it down to the coast, otherwise they must await the visits of petty retail dealers from the ports, who enter the country with ventures of ten or twelve dollars, and barter for it cloth, beads or wire. The Kossi, south-west or rainy monsoon, is the only period of work; the Kaskazi, or dry season, is a dead time. The hardness of the ground is too much for the energies of the people; moreover, "Kaskazi Copal" gives trouble in washing on account of the sand adhering to its surface, and the flakes are liable to break.

As a rule, the apathetic Moslem and the futile heathen will not labor while a pound of grain remains in their huts. The more civilized use a little jembe or hoe, an implement about as efficient as the wooden spade with which an English child makes dirt pies. The people of the interior "crow" a hole about six inches in diameter with a pointed stick, and scrape out the loosened earth with the hand as far as the arm will reach. They desert the digging before it is exhausted, and, although the laborers could each, it is calculated, easily collect from ten to twelve pounds per diem, they prefer sleeping through the hours of heat, and content themselves with as many ounces.

Wherever upon the coast there is a blood feud, and

these are uncommonly frequent, a drought, a famine, or a pestilence, workmen strike work, and cloth and beads are offered in vain. It is evident that the Copal mine can never be regularly and efficiently worked as long as it continues in the hands of such unworthy miners. The energy of Europeans, men of capital and purpose, settled on the seaboard with gangs of foreign workmen, would soon remedy existing evils, but they would require not only the special permission, but also the protection of the local government. And although the intensity of the competition principle among the Arabs has not yet emulated the ferocious rivalry of civilization, the new settler must expect considerable opposition from those in possession. Though the Copal diggings are situated mostly beyond the jurisdiction of Zanzibar, the tract labors under all the disadvantages of a monopoly; the diwans, the heavy merchants, and the petty traders of the coast derive from it, it is supposed, profits varying from 80 to 100 per cent.

Like other African produce, though almost dirt cheap, it becomes dear by passing through many hands, and the *frasilah*, worth from \$1 to \$3 in the interior, acquires a value of from \$8 to \$9 at Zanzibar.—Burton, *Lake Regions*, p. 435.

A writer in the *Geographical Magazine* also adds the following notes on Copal:

“The *Msandarusi*, or Copal tree (*Trachylobium* Sp.), according to Capt. Elton, is largely scattered over an extensive tract of country in the *Mrima* or coast region. This

tract lies along both banks of the Lufiji, and extends from the mountains to the sea, a belt from thirty to thirty-five miles wide.

“Throughout these limits immense quantities of the semi-fossil gum are dug up by the natives, and this constitutes the most lucrative commerce of the Indian settlers at the small trading ports. Further south, beyond the Lufiji, there is a break in the supply, attributed by Capt. Elton to the surrounding slave traffic, which rapidly drives legitimate commerce out of its course, but also affected by the increased difficulties of communication caused by the marshy swamps which here fringe the coast more deeply than above the Lufiji. Beyond Kilwa Copal again appears and is largely brought up in tranquil times at the numerous trading stations which dot the seaboard down to the Rovuma River.

“The Copal tree is a large tree. The bark is smooth, the trunk of a yellowish white tinge, rendering the tree conspicuous amid the dark African jungle growth, and is dotted with exudations of raw gum, which is also found scattered in bits about the base.

“The forests, called Kiregesi, contain many Msandarusi or Copal trees, and between them, in the broad transverse glades which always intersect African woodlands, some of the finest fossil gum is dug.

“This never reaches the trader, however, without a large admixture of the Copal from the neighboring trees, and the contents of the digger’s basket are made up with wet sand and small stones in order to give it a little extra

weight. The chief centre of supply is the Kwale district, where there are eleven stations for carrying on the Copal trade. In the early morning strings of natives are seen on the paths, each party led by a few men armed with old muskets, and consisting of women and lads, carrying Copal baskets.

“Except during the very dry season these arrivals take place daily, but there is no organized system of working.

“The Indian traders do not venture to send out parties of their own, for each village and each working is represented by a head man, and the natives are only too ready to unite against the slightest encroachment on their monopoly. The ‘trade-union’ system is here represented in its strongest form.

“Below four feet no gum is found worth taking, and very few diggers go beyond three feet in search of it. The trade appears to be surrounded by many difficulties. The Indian trader on the Mrima coast has many extortions to contend against, and heavy duties to pay, beside the continual haggling with the natives, competition with his neighbors, and a perpetual round of coast fevers. The local village head man extracts a ground rent from him, and he has to pay an arbitrary percentage on his profits, and twenty out of every hundred frasilahs of Copal shipped, as an export duty. The cost is from \$3 to \$5.25 per frasilah of Copal, varying according to the season of the year, and at Zanzibar the merchants buy at from \$7 to \$8. Yet, in spite of all difficulties, the trade prospers, and Capt. Elton is of opinion that the inexhaustible

supply of Copal under a settled rule, and with systematic working, would furnish the means of supporting a far larger community than that which is now sparsely scattered along the coast.

“In old days the trees would appear to have lined the shores, but the extent of the ancient forests can now only be estimated by the area of the present workings, and by the positions of the existing Msandarusi which are found away toward the foot of low hills bordering the Mrima, and on all the terraced lands sloping down from the ridges to the present sea-beach. Msandarusi is the true or ripe Copal, the produce of vast extinct forests, and buried at depths beyond atmospheric influence.

“The raw or tree Copal is called Chakazi. It is little valued in European markets, but is exported to Bombay and China.”

IV.

“LUFUJI RIVER AND THE COPAL TRADE.”*

The River Lufji, though entirely unknown beyond its delta, is one of the most important rivers on the east coast of Africa. Rising, as is supposed, in Lake Rwaha, in about the longitude of Unyanyembe, but far to the south, it receives the drainage of all the southern slopes of the Usagara and Ugogo country, along which Burton's route passed from the coast to Unyanyembe, and falls into the sea opposite the large island of Mafia, about 100 miles south of Zanzibar.

Burton collected all that was known of the Lufji, which in its upper course is called the Rwaha River; and he observed that the exploration of its delta was still a desideratum † This desideratum has now been supplied. In 1878 Dr. Kirk and Capt. Wharton, of H. M. surveying ship “Shearwater,” explored the Lufji Delta ‡ in a steam launch; and this year it was again explored by Capt. Elton, First Assistant to the Political Agent at Zanzibar, who has also furnished some very interesting information respecting the Copal diggings to the south of the port of Dar-es-Salam.

The Msandarusi, or Copal tree, according to Capt. Elton,

* Published in *Geographical Magazine* (London, Trübner & Co.), August, 1874.

† *Royal Geographical Society's Journal*, xxix., p. 44.

‡ *Royal Geographical Society's Proceedings*, January, 1874.

is largely scattered over an extensive tract of country in the Mrima or coast region. This tract lies along both banks of the Lufji, and extends from the mountains to the sea, a belt of from 30 to 35 miles wide. Throughout these limits immense quantities of the semi-fossil are dug up by the natives, and this constitutes the most lucrative commerce of the Indian settlers at the small trading ports. Further south, beyond the Lufji, there is a break in the supply, attributed by Capt. Elton to the surrounding slave traffic, which rapidly drives legitimate commerce out of its course, but also affected by the increased difficulties of communication caused by the marshy swamps which here fringe the coast more deeply than above the Lufji. Beyond Kilwa Copal again appears, and is largely bought up in tranquil times, at the numerous trading stations which dot the seaboard down to the Rovuma River.

The Copal tree is described by Burton as a large tree, the towering bole of which has formed canoes 60 feet long. The bark is smooth, the trunk of a yellowish white tinge, rendering the tree conspicuous amid the dark African jungle growths, and is dotted with exudations of raw gum, which is also found scattered in bits about the base. The forests, called Kiregesi, contain many Msandarusi or Copal trees, and between them, in the broad transverse glades which always intersect African woodlands, some of the finest fossil gum is dug. This never reaches the trader, however, without a large admixture of the Copal from the neighboring trees, and the contents of the dig-

ger's basket are made up with wet sand and small stones, in order to give it a little extra weight. The chief centre of supply is the Kwale district, where there are eleven stations for carrying on the Copal trade. In the early morning strings of natives are seen on the paths, each party led by a few men, armed with old muskets and bows and arrows, and consisting of women and lads, carrying Copal baskets. Except during the very dry season, these arrivals take place daily, but there is no organized system of working. The Indian traders do not venture to send out parties of their own, for each village and each working is represented by a head man, and the natives are only too ready to unite against the slightest encroachment on their monopoly. The "trade-union" system is here represented in its strongest form.

Below four feet no gum is found worth taking, and very few diggers go below three feet in search of it. The trade appears to be surrounded by many difficulties. The Indian trader on the Mrima coast has many extortions to contend against, and heavy duties to pay, besides the continual haggling with the natives, competition with his neighbors, and a perpetual round of coast fevers. The local village head man extracts a ground rent from him, and he has to pay an arbitrary percentage on his profits, and 20 out of every 100 frasilahs of Copal shipped, as an export duty.

The cost is from \$3 to \$5.25 per frasilah of Copal, varying according to the season of the year, and at Zanzibar the merchants buy at from \$7 to \$8.

Yet, in spite of all difficulties, the trade prospers, and Capt. Elton is of opinion that the inexhaustible supply of Copal, under a settled rule, and with systematic working, would furnish the means of supporting a far larger community than that which is now sparsely scattered along the coast.

In old days the trees would appear to have lined the shores, but the extent of the ancient forests can now only be estimated by the area of the present workings, and by the positions of the existing Msandarusi which are found away towards the foot of the low hills bordering the Mrima, and on all the terraced lands sloping down from the ridges to the present sea-beach. Msandarusi is the true or ripe Copal, the produce of vast extinct forests, and buried at depths beyond atmospheric influence.

The raw or tree Copal is called Chakazi.

It is little valued in European markets, but is exported to Bombay and China.

V.

JACKSON.

"SOURCES OF COPAL," BY JOHN R. JACKSON, A.L.S., CURATOR OF THE MUSEUM, ROYAL GARDENS, KEW.*

Copal is an article well known to commercial men, but the source or sources whence it is derived are very imperfectly known to botanists. The term Copal is so generally applied to the better or clearer kinds of resin used for varnish making, that it seems after all to be a somewhat indefinite term, yet Copal, anime, and dammar, are distinct commercial names for very distinct resins, and the sources of all of them are more or less shrouded in mystery; indeed there seems to be a similar chronic doubt with many of our imported resins, for olibanum and some others of that class have long been subjects of inquiry amongst botanists and pharmacutists not only in England, but in other European countries. Several sorts of Copal are known in British trade, as Brazilian, Indian, African, &c., the produce of different plants, but as an illustration of the difficulty of solving the question accurately as to the names of these plants, we may mention that what is known in commerce as Bombay anime is not an East Indian product at all, but is sent to Bombay from the East African coast, and then reshipped to England, so

* Published in Student and Intellectual Observer (London, 1869), Vol. III., p. 356.

that the commercial name, in this instance as in many others, is no guide, but rather leads us astray in reckoning upon the geographical position of the plant.

Dammar, or, East Indian Copal, is said to be the produce of *Vateria Indica*; piney resin, of which very little, we believe, is now imported, is said also to be produced from the same tree. Yet piney resin is very different in appearance to what is commercially known as Indian Copal; it is, nevertheless, a good, clear resin, and gives off, while burning, an agreeable fragrance, so that the natives on the Malabar coast make candles of it; ornaments such as beads, &c., are also made from it, and they much resemble amber. Much of the dammar as seen in our markets is, no doubt, the produce of *Dammara orientalis*, a large coniferous tree growing in the Moluccas. *Dammara australis*, a New Zealand tree, furnishes Kawrie resin, sometimes known as Australian dammar and Australian Copal; it is dug up from a depth of two or three feet below the surface of the ground. The natives are very quick in discovering it, probing the ground with long iron spikes, and sometimes alighting on extensive beds. The resin is dug up in very large masses or blocks, sometimes as large as a man's head.

In India many kinds of dammar are known, as, for instance, black dammar, said to be produced from *Canarium strictum*, Saul dammar, from *Shorea robusta*, and so on, the botanical sources of many of which are unknown. What is known in commerce as Brazilian Copal is probably produced by species of *Hymenæa*.

Dr. Daniell, who resided some time in West Africa, and who published a paper on Copal in the Pharmaceutical Journal in 1857, classes the commercial sorts into three distinct kinds—East Indian, American, and African. As regards the former, it has since been proved, as we have before said, to be sent originally from Eastern Africa to Bombay, and reshipped from thence to Europe.

But the true Indian Copal or minul, and which is sometimes called piney resin, is doubtless furnished by *Vateria Indica*. The American, Dr. Daniell divided into two sections—Mexican and Brazilian, or North and South American. Amongst the plants yielding this description of Copal were enumerated *Icica*, *Elaphrium copalliferum*, *DI.*, and *E. excelsum*, *H.B.K.*, *Rhus copallinum*, *L.*, *Trachylobium martianum*, *Hayne*, and other species of *Trachylobium*. Whether or not commerce is indebted to all these plants to increase the bulk of that resin, so valuable in this country, we are not prepared to endorse; but considering that the *Hymenæa courbaril*, *L.*, is a well-known, indeed a common, tree in the West Indies, Brazil, Guiana, and, in short, in most parts of tropical South America, and knowing that from this tree exude large quantities of a clear Copal-like resin, it is not unreasonable to suppose that it may be one of the trees from which our supplies of Copal are obtained. Masses of this resin from the *Hymenæa* were exhibited in the British Guiana collections of the International Exhibition of 1862, and in Paris in 1867. The trees, which are known in British

Guiana as Simiri or Locust, grow in the forests of that colony to a great height, often reaching sixty or eighty feet before a branch is given off.

The lower part of these gigantic trunks is supported by huge buttresses, a representation of which is given by Martius, and copied at p. 551 of Lindley's "Vegetable Kingdom."

Even above these buttresses, when the trunk is cylindrical, they have been found to measure as much as sixty feet in circumference, and, as regards their ages, it has been computed that they must have been large trees at the commencement of the Christian era. The wood is exceedingly hard and dense, and a good deal of it is brought into this country for use as tree-nails in planking vessels, as well as for beams and planks for heavy engine work. The gum or resin, which in the colony is called gum-anime, and which is of a very clear yellow color, is said to be found only by digging near the roots of the trees. Some specimens which were shown in the International Exhibition, 1862, and which are now in the museum at Kew, have not the slightest trace of the fretted surface known as "goose-skin," which is found on the best African Copal, though the large masses or blocks have somewhat the appearance of a stalagmitic formation, and a peculiar worn or dirty appearance where it has not been made bright by recent fracture. Air bubbles, channels in which pieces of stick have been imbedded, insects, and such characteristics common to Copal, also occur in this resin. Though digging near the roots of the trees is

said to be the usual way of obtaining it, it will nevertheless flow freely upon tapping the tree; the juice exuding and hardening on the trunk, large solid masses are quickly formed. That the trees are highly charged with resin, can be easily seen from the fruits themselves; the large woody pods when dry are covered with little warts or irregularities, which, upon scratching, will be found to be mere resinous secretions, simply covered with a thin epidermis. The fruits of *Trachylobium mossambicense* are much more highly charged with resin, for while the fruits themselves are not more than a tenth the size of those of *H. courbaril*, the tubercles are considerably larger and consequently contain much more resin; further than this, the pods are not so ligneous, so that the resin is more diffused amongst the tissues; this resin is of a very light color and transparent, and burns freely with a clear flame.

Fine specimens of the bark of this tree (*Trachylobium mossambicense*, Kl.) with the resin *in situ* are in the museum at Kew, and were received from Lieut.-Col. Playfair during the period of his residence as Consul at Zanzibar.

The resin as seen in these specimens is of a dusky exterior, but bright clear yellow fracture, scarcely so light in color as Sierra Leone Copal, and hardly so dark as that known as Zanzibar Copal. This difference in color may be one of the distinctions between the fossil and recent resins, that exposed on the trunk being in a measure bleached by the action of light and air. From the mate-

rials sent to Kew by Lieut.-Col. Playfair, a year or two since, it seemed tolerably clear that Zanzibar Copal was the produce of *Trachylobium mossambicense*, Kl., and Dr. Kirk, the present Vice-Consul in Zanzibar, has confirmed this in a recent letter.

His conclusions have been arrived at from a careful examination of the plants, their position of growth, their resinous properties, and the care with which the resin is collected and sorted. These notes of Dr. Kirk are exceedingly interesting, and were made during a holiday trip on the African mainland, opposite the southern end of the Island of Zanzibar, where a large creek offers a naturally formed harbor.

The vegetation of the sea-shore is composed of *Rhizophoras*, *Brugueiras*, *Avicennias*, *Sonneratias*, &c. This characteristic tropical vegetation forms a belt or line, behind which, and within a few paces of the water's edge, the ground suddenly rises to a height of about thirty feet, from whence a flat plain extends inland for a distance of about twenty miles. A section of this would show a formation of sand, gravel, vegetable mould, and clay, and occasionally beds of water-worn pebbles.

The vegetation of the neighborhood of this creek of Dar-es-Salam is very varied, and, among other hard or heavy wooded trees and bushes, the *Trachylobium mossambicense* is conspicuous from its white flowers and rounded head of glossy leaves. This tree is known to the natives as the Msandarusi, or tree of Copal. Dr. Kirk says, "On examining the tree more closely, the trunk and main limbs

were seen to be covered with the clear resinous exudation now brittle and hard; from the upper branches it dropped down on the ground below, but not in a fluid state. To judge by the appearance it presented, I should say that the resin soon dries and hardens after being exuded, but must be easily broken off by violence. Pieces of various tint and form were collected, some with insects imbedded' but all presented a smooth polished exterior, quite free of any pitting or 'goose-skin' known on all kinds dug up from the ground. This sort is known in trade as Sandarusi za m'ti, or Copal from the tree. It is exported in considerable quantity to India, but not to Europe."

Dr. Kirk further believes that this same tree, the *Trachylobium mossambicense*, is the source of the true Zanzibar Copal, the half-fossilized resin known in English commerce as anime, and which is one of the most valuable sorts for varnish making imported. In the Copal trade at Zanzibar alone, the merchants have three distinct kinds, which they again subdivide into classes according to the color, form, surface, etc., for Copal has many peculiarities known only to those who trade in the article, though sometimes these peculiarities affect the quality and price of the resin. One sort, the Sandarusi za m'ti, or tree Copal, which we have referred to, Dr. Kirk thinks never enters European commerce. It is gathered from the trunk of the *Trachylobium* which grows all along the coast from Mozambique to near Lamo, or from 3° to 15° south latitude.

It, however, occurs in greatest abundance between

Cape Delgado and Mombas, "but becomes very rare," we are told, "at a little distance inland, and quite unknown long before the change in geologic structure offers an explanation for its absence." The sea-shore appears to offer advantages for its growth, as the plant will not flourish far inland.

Another kind of Copal is known to the merchants as Chakazi, which has been by some corrupted into "Jack-ass."

This resin, unlike the last, is dug from the ground, but is apparently of comparatively modern deposit, being found either near the roots of living trees, or in that part of the country where the trees at present exist. It is, however, said that the source of this quality of resin is found inland in extinct forests. This statement Dr. Kirk receives with doubt, inasmuch as the traders constantly mix this with the more valuable produce of the interior.

The third sort, known as the true Sandarusi, fetches the highest price, and is the true Copal or anime of the English markets. It forms the bulk of the Zanzibar Copal, and is dug from the soil in extinct forests farther inland than where the tree is now seen. These forests extend "all along the ancient sea-beach, the maritime plain, which here fringes the continent to a depth of twenty to forty miles in general. Some spots are richer than others, and soils indicate good 'diggings.' When the rains which follow the north-east monsoon have softened the soil, the natives of the country commence to dig. They form small pits, searching the soil as removed, but there is no

system; and like the gold washings of Africa, so the Copal regions yield not a fraction of what a little system and industry might produce. At present every clan-feud stops the search. The producer receives, even when successful, only a trifle from the Indian merchants, who again part with it, after paying enormous dues to the Zanzibar state, to the European and American traders."

The quantity of Copal exported from Zanzibar has been known to amount, in some years, to 800,000 pounds, valued at £60,000. The supply, however, of the best kind, namely, the fossil resin; is unlimited. The extent over which it is spread is so considerable that almost any quantity might be collected with a little system and if more inducement to work was held out to the laborers.

The conclusions to be deduced from Dr. Kirk's remarks are these: That Zanzibar exports three distinct kinds of Copal, one of which is always produced from the trunks of the living trees, and is, therefore, never seen in a fossilized state, and that this resin is never exported to Europe, the other two kinds alone finding their way into English commerce.

The first of these two, known in the trade as Chakazi, though always dug from the soil, is of modern formation, as it is always found in the neighborhood of existing trees, and, though slightly marked with the impress of the sand or "goose-skin," it has evidently lain only just long enough to receive it. The second is the most valuable of all the kinds of Copal known in commerce. It is harder and less soluble than any other sort, yet it produces a very

elastic and brilliant varnish, and this sort is found only in extinct forests. We will, however, give Dr. Kirk's conclusions in his own words: "If we take into account the similarity of recent and fossil resins in appearance, their near approach in physical property, the fact that the recent gum, after being imbedded in sand, takes the characteristic surface markings, and recollecting that where now the good Copal is dug as a fossil the present Copal tree, in all probability, once grew, when the sea was nearer to the hills than now, I think we may be satisfied that the present *Trachylobium* was the source of the old Copal, which is the resin only modified by time and long exclusion from air and light under the ground."

The fact of insects and other substances being found in Copal, whether recent or fossil, is easily accounted for.

The tenacity of the resin when in a semi-fluid state readily entraps all bodies coming in contact with it, and so, with the continued flow and the quickness with which it hardens, insects and other substances are easily embalmed, and, considering that the resin flows from the under side of the principal branches of the tree, the fruits, flowers, or twigs of the undergrowth or lower vegetation would be likely to be caught by the exuding resin, and so preserved.

Dr. Kirk points this out as a very probable reason why some portions of the plant of the *Trachylobium* itself are never found embalmed, and adds that the heavy, glossy

foliage would be less likely to adhere than the foliage and twigs of the smaller-growing surrounding vegetation.

From Dr. Kirk's letter, together with the fine series of specimens recently received from him at the Kew museum, much light is thrown on the origin of the East African Copals, and we hope further researches will entirely clear up this, one of the many tangled knots in economic botany.

VI.

RAFFRAY.*

M. RAFFRAY presented the following:

"I lay before the Society some pieces of Gum Copal, rough and polished, containing insects, and which come from Equatorial Africa.

"Gum Copal, which at Zanzibar is the object of a very important commerce, is secreted by a tree of large size, which I have often noticed in the Schima Mountains. As the gum is furnished by the lower parts of the trunk and the roots, there is nothing strange in the fact that it contains insects which have been limed when it was in a viscid state; these insects are preserved in a most perfect condition, and with all the natural freshness of their coloring, in spite of a lapse of time which may be counted by centuries, for the gum required by trade, and, in particular, the specimens which I exhibit to the Society, date from an epoch excessively remote, and one which may only be fixed precisely by geology. The gum is found at a depth of one metre to one metre and a half in the soil on the plains, at about twenty days' march from the sea-coast. These plains are very probably alluvial terraces; they contain few trees, and especially no Copal-bearing trees. It is, therefore, almost a fossil gum. The gum gathered from the living tree is disregarded in trade

* *Annales de la Société entomologique de France*, Tome 5, Part III., 1875.

on account of its not possessing in so great a degree the qualities required for the manufacture of varnish.

“The gum thus obtained from the soil (and it is from large quantities of this that I picked the pieces I now exhibit to the Society) shows a granular surface, somewhat similar to Morocco leather, a characteristic I have not noticed in the fresh gum, which is almost smooth. The insects enclosed in the gum belong to all the orders; there is even a Microlepidopter, but they are generally arachnidæ, ants, or xylophagans, and also a considerable number of diptera. The most remarkable, on account of their form, are a cicada and a cricket. Among the Coleoptera I think I have recognized a Brenthide, very common to-day on the bark of trees, the *Ceocephalus picipes*. I believe, if the fauna of these regions was better known, that all the species contained in the gum might be found living.”

VII.
HOPE.

“DESCRIPTION OF SOME UNDESCRIBED INSECTS FOUND IN
FOSSIL RESIN,” BY THE REV. F. W. HOPE, MEM-
BER OF THE ROYAL, LINNEAN, AND ENTO-
MOLOGICAL SOCIETIES OF LON-
DON, ETC.*

GENUS, *Monomma*. Klug.

The Resin *Monomma* (*M. des Résines*).

M. Resinorum. Hope. Pl. 2.

Black; head dark, antennæ piceous; thorax convex and punctulate, with subsinuate anterior and posterior margins; elytra black, strongly punctate; legs piceous.

Length, $6\frac{1}{2}$ millimetres.

Habitat: Probably in the island of Cernensi; described from fossil resin in the cabinet of the author.

Prof. Klug, of Berlin, in his descriptions of insects from the island of Madagascar, has given the generic name of *Monomma* to an insect received from that region, adding to the appellation N. G., thus indicating a new genus. In his Plate 4, Fig. 6, j.h., he also gives some anatomical figures; but as he has omitted many remarkable characters, particularly the prosternum and the edges recurved beneath the elytra, I thought it useful to figure all the details of the exterior organization of this insect. I re-

* Published in *Mag. de Zoologie* (Paris, 1842).

tain the generic name published by Klug, and abandon that of *Hipporhagus*, Dejean, which I consider a study name (*i.e.*, not published).

Genus *Calcar*? Latr.

C.? *inhumatus*. Hope. Pl. 3.

C.? piceous; antennæ longer than thorax; head with an impressed front, thorax cordate, anterior angles wide and rotund, posterior abruptly truncate and straight; elytra with round apices, almost three times longer than the thorax, striate-punctate, strongly impressed with punctæ; legs piceous, thickened.

Length, 6 millimetres.

Described from fossil resin in the cabinet of the author.

It is with hesitation that I give the name of *Calcar* to this insect. In its form it approaches the genera *Læna* and *Calcar*, but it differs from these two genera, and offers some points of resemblance to the *Xylophagi*. It will perhaps become the type of a new genus near to *Calcar*. It differs from *Læna*, as the latter has much longer antennæ, and it differs also in many other ways. In the joints of the antennæ it differs greatly from the genus *Calcar*, and shows many other differences not less striking, but I do not mention them here, as the characters of this insect are very well represented by Mr. Westwood.

I leave it to the entomologists to form an opinion upon this insect, and upon the opportunity afforded by it to form a new genus.

Megalocera. Hope.

Head anteriorly rotund, eyes quite prominent. Antennæ with eleven joints, trigonal-serrate; first joint thick, second short, the succeeding ones trigonal and gradually increasing in length, but the last with a longer acute apex.

Thorax a little wider than the head, with sides medially convex. Elytra four times longer than the thorax, parallel, striate-punctate, with rotund apices and rectangular shoulders. Legs simple.

M. rubricollis. Hope. Pl. 4.

M. black, thorax convex, dark elytra, striate-punctate, with punctæ strongly impressed and colored similarly to the legs.

Length, 6½ millimetres.

Found in fossil resin, and described from the collection of the author.

VIII.

WELWITSCH.

**"OBSERVATIONS ON THE ORIGIN AND THE GEOGRAPHICAL
DISTRIBUTION OF THE GUM COPAL IN ANGOLA,
WEST TROPICAL AFRICA," BY FRED. WEL-
WITSCH, M.D., F.L.S. (READ FEB.
15, 1866).***

At the meeting of the Linnean Society on the 21st of December last year, a paper on amber was read, and reference was made to the various kinds of Gum Copal. I much regret that illness prevented my being present at that meeting, but being desirous to contribute somewhat to the knowledge of this valuable resin, I take the liberty of offering the Linnean Society some remarks on this subject, mostly taken from notes and observations made during my travels in West Tropical Africa. If my observations are not conclusive, especially with regard to the species of trees which at present furnish, or may have formerly furnished, this resin, I hope at least to be able to show that nearly all the opinions heretofore published on this subject are more or less erroneous; and my remarks may therefore induce future researches in a different direction which may lead to a more satisfactory result.

I shall commence my remarks by stating the most im-

* Published in Journal of Linnean Society, Botany (London, 1866).

portant facts as to the nature and appearance of Copal and its geographical distribution in Angola; next I shall speak of its varieties and its mercantile importance; and, finally, say a few words on the supposed origin of this valuable resin, stating the observations of other authors, and the views formed by myself during my residence in Tropical Africa.

I. On the occurrence, appearance, the geographical distribution, and the manner of gathering Gum Copal in Angola.—Gum Copal, which is called by the Bunda negroes *Ocote cocoto*, or *Mucocoto* (and which is found in the hilly or mountainous districts all along the coast of Angola, including the districts of Congo and Benguella, lately united with that province, and also in some places even further east), is brought by the natives to the different market places on the coast of Angola near the Atlantic Ocean, amongst which the most important are Ambriz, Loando, Novo Rodondo, Benguella, and Mossamedes. The larger quantities of this resin are mostly found in the sandy soil which is studded with thorny bushes of *Acacia*, *Dichrostachis*, and aphyllous *Euphorbiæ*, or sometimes covered here and there with forests of *Diospyros*, *Leguminosæ*, *Cæsalpinæ*, *Combretaceæ*, and *Celastrineæ*, and which is situated in the hilly region extending, with little interruption, across 700 geographical miles southwards, at the foot of the first terrace, from the river Zaire to Cunene. The hilly tract itself, which in its greater portion is rocky or stony, is often intercepted by extensive sandy plains, rising slightly, and extending

inland to the foot of the first chain of mountains, upon which the above-named trees mostly appear as bushes or low dwarf shrubs; and among them are also observed the *Mærua Angolensis* and other Capparidææ, several Loganiaceæ and Acanthaceæ, bushes of a species of *Balanites*, dwarf specimens of *Hyphæne* and a *Bauhinia*. Almost the whole of this region, which we may call the inner littoral region, bears a dull, desolate aspect; and it is only in slopes and in deep ravines, where a stratum of red clay may be seen, that a varied and luxuriant vegetation occurs, which gradually increases toward the small lakes and rivulets, and which on the banks of the large rivers manifests all the richness and variety peculiar to equatorial countries.

The higher slopes of the hills next to the mountains are covered more or less with extensive forests, which, according to different latitudes, consist of Diospyrææ and Combretaceæ, or sometimes of Sterculiæ and Cynomatiæ, and in the southern districts of Mossamedes, of the *Copaifera Mopane*, lately described by Mr. Bentham in the last published part of the Linnean Transactions. In the hills and undulations of gravelly soil, between the rivers Dande and Bengo, in the north of Loando, and there only, I met with an area of more than ten miles nearly exclusively covered with *Hyphæne* Palms, which are probably identical with the *Hyphæne crucifera*, Pers.

After several years of observation in various places of this region, I conclude that these palm forests covered in past ages a great portion of the coast districts of Angola,

where, however, at present they only appear as dwarf bushes without stems, and never blossom.

This gradual falling off in the vegetation is observable in a similar manner in several other dwarf shrubs belonging to the Rubiaceæ, Jasmineæ, Combretaceæ, and especially in the *Mærua Angolensis*, which is the one most frequently found, but which, during my numerous wanderings, I only met with three or four times, developed as full-grown trees. The only kind of tree which seems to brave this general dwindling away of vegetation is the well-known *Adansonia*, which is seen in full splendor throughout the district, either singly or in groups.

The rains which fall in this region are almost without exception passing thunder storms, discharging within a few hours immense quantities of water, which flows immediately into rivers or the sea, thereby doing little good to the thirsty, sandy soil.

Still these rains, which produce here and there small rivulets, furrowing the soil in every direction, enable even the sandy plains to bring forth, for a few months during the year, a lovely green, chiefly of Gramineæ, Cyperaceæ, Leguminosæ, and Compositæ.

Immediately after these heavy rains, the temperature rises to so high a degree, that, within a few days, a great number of delicate plants fade away; and even shrubby plants suffer sometimes so much that they do not blossom, or do not bring forth ripe fruit during several years.

This may be one of the many reasons which have caused

the gradual dwindling away, and, I might say, the dwarfing, of the vegetation in this region. The breadth of this littoral region, from the shores of the Atlantic Ocean to the foot of the first high terrace, varies very much, according to the different curves of this last-named mountain ridge; sometimes (for instance, near Libongo and the Dande) it only measures a few miles, whilst at other places, near the Bengo River, it extends inward fifty or more geographical miles. In many places where the mountain ridge of the terrace is intercepted by wide clefts, or by broad valley slopes, this littoral region is extended far into the mountain terrace itself, forming in the middle of the primeval forests larger or smaller sand oases, covered with low shrubs or single dwarf trees. On the other hand, the luxuriant and varied vegetation of the primeval forests reaches sometimes from the terrace close down to the Atlantic coast district, especially along the narrow vales abutting on the sea, and still more so those extending along the banks of the larger rivers like the Zaire, the Loge, Dande, Bengo, Cuanza, and the Cotumbella.

In such places the traveller suddenly finds himself, to his great surprise, transported within a few paces from a barren desert into a landscape abounding in the richest crops, among which are seen the bright green of the Oil Palm and the majestic foliage of the graceful Raphias, whilst the towering crowns of the Bombax, several varieties of Ficus, and the beautiful slender Cocoa Palm, sometimes alone, and sometimes in small groups, spread high above the exuberant mass of vegetation.

From the fact of the coast district penetrating here and there with its vegetation into the high mountain terrace, it follows that its limits towards the interior of the continent do not form a clearly defined curve, but rather a sharp zigzag line, which accounts for Gum Copal being sometimes found in places far inland.

Trusting to the reports of others, and to my own experience, I believe that I may assert that the geographical distribution of the *Adansonia digitata* circumscribes in West Tropical Africa, and particularly in Angola, the limits within which Gum Copal is found at present, or will be found in future. In those districts of Angola, rising more than 3,500 feet above the level of the sea, and in which the *Adansonia* is rarely met with, and generally not at all, it appears that no Copal is found, nay, even at the height of 2,500 feet it is seldom found, and only in very few places.

Of all the districts constituting the province of Angola, the lands in the interior belonging to the government of Benguella yield the most. They extend south of the Cuanza River, along the western ridge of the mountain terrace of Amboin, Selles, and Mucobale. The quantities of this resin exported from Benguella amounted from 1850 to 1860 to 80,000 arrobas, i.e., 1,600,000 pounds per annum.*

I have been circumstantial in defining the region where the Gum Copal of Angola is mostly found, and in giving a general description of its vegetation; for it is obvious

* T. A. de Souza, in Alman. de Cambr., 1858, page 234.

that it must be in this region where we must search for and find the trees which furnish the Gum Copal, and which, according to most of the published reports, are growing there even now in large numbers. This is a question to which I shall return after having given some details with regard to the occurrence and the way and manner of gathering this resin.

It is a general and widely spread opinion that the Gum Copal in Angola is gathered from trees; but this, according to my own observation, is obviously erroneous; for the Gum Copal is either dug out of the loose strata of sand, marl, or clay, or else it is found in isolated pieces washed out and brought to the surface of the soil by heavy rainfalls, earthfalls, or gales; and such pieces, where found, induce the negroes to dig for larger quantities in the adjacent spots. This digging after larger quantities is, as may be supposed, often very successful; but sometimes it is less satisfactory, or totally without result, just in the same manner as with people digging for gold.

At times numerous larger and smaller pieces of Copal are found close to the surface of the sand, or within the depth of a few feet, whilst in other places, after digging to the depth of five to eight, or even ten, or more feet, only single pieces, or sometimes none at all, are brought to light.

As soon as a negro has discovered in any spot one or more pieces of Copal, he hastens to his relations and to his commercial friends, telling them of his fortunate treasure-

trove, showing what he has found, and concludes with them a kind of treaty of partnership, whereby he becomes entitled to the larger share in the probable gains.

The members of this partnership then provide themselves with digging implements, including large sacks, mostly made of the bark of the *Adansonia* or *Raphia* leaves, and they then proceed to the indicated spot to commence researches.

As is natural, such a spot and its neighborhood are not left until the diggers have convinced themselves that they have completely exhausted the district, or that no more Gum Copal is to be found beyond the first indicating pieces. In the latter case it is supposed that the first pieces met with were washed down from afar, and further researches are then made accordingly.

On these journeys the Copal gatherers often separate from each other for several days, during which time they pass the nights round a fire in caverns, or places hidden by thickets, so as to recommence their work early every morning. Searching after Gum Copal is frequently combined with the gathering of *Urzella* (being different varieties of *Rocella fuciformis* growing on trees), which, however, only takes place on that part of the littoral region which is situated near the coast, as this lichen does not grow far inland; even on the border of the first mountain terrace it is only seen here and there in single specimens, or it entirely disappears. On these occasions the Gum Copal seekers also gather several other gums, including the Gum Arabic, which is found on the *Acacias*

in these countries. This accounts for the fact that amongst the Gum Copal which is brought to market a few resins and pieces of Gum Arabic are also found.

If, after prolonged researches in the same district, no more Gum Copal is found, the diggers leave that place; the secured resin is cleaned by washing, and packed in sacks, to be ready for sale in the markets on the coast. Different varieties of Gum Copal of unequal value being often obtained on the same spot, the resin, when brought to market, has to be sorted before being sold.

It is classified mostly according to its color; and the price is determined by weight.

The deep colored quality is generally worth double the price of the lighter sort.

This brings us to—

II. Considerations on the different varieties of the Gum Copal of Angola, and their mercantile importance.—The shape in which Gum Copal is found is very various; it often has the form of an egg, a ball, or a drop; at other times it looks like a flat pressed cake; and it is also met with in sharp-canted pieces.

The pieces of Gum Copal vary as much in size as in shape; they are rarely larger than a hen's egg, and there are many much smaller; others (which, however, seldom occur) are as big as a man's fist, or even a child's head, weighing three to four pounds and more.

All the pieces of Gum Copal of different shape and size have one common characteristic, viz., that on their surface they are covered with a thinner or thicker close-sticking,

whitish, nearly chalky crust, which exhibits on many pieces veins or net-work, whilst in most instances it covers the surface like an earthy, powdery coat. The surface of fresh-broken pieces appears conchoidal, with finely radiating lines in each conchoidal impression. The lustre is glossy; the mass is hard, and transparent to a certain depth, and where scratched with a knife or needle it leaves a white-powdered stroke. It can easily be scraped with a knife into powder, which, if sprinkled over red-hot coals, changes instantaneously into thick vapors, at first with a slight yellow color, with a strong aromatic smell, somewhat similar to that of incense. Large pieces brought into contact with a light soon burn up, developing, at the same time, the above-mentioned vapors. When chewed, it crackles between the teeth, without leaving a noticeable taste. Whether Gum Copal has ever been subjected to a thorough chemical analysis, I do not know; but no notice or account of it is given in the "*Histoire des Drogues*," by Guibourd, in which work are found the analyses of many East Indian and American Copal resins.

The fact that there is often seen, even on the canted, broken sides of many pieces, the same hard, whitish, earthy crust which covers the other unbroken surface of the same piece, tends to prove that after their falling off the mother tree they were forcibly transported from their original spot by floods or earth falls, by which they were broken before they came into the marl or sandy plains in which they are now found. At times the crust just

alluded to is very hard, of considerable thickness, and with a glossy polish, which leads to the supposition that pieces in which it is found have been imbedded for a long time in the ground, or, perhaps, in water-basins. Whilst an earthy crust of greater or less thickness is noticed on all pieces of Gum Copal before it is washed or rubbed off, the color in different pieces varies very much; some samples are yellowish white, some of honey or gold color, and others are distinguished by an intense reddish orange color. The general appearance of the pure pieces of this resin, especially the gold colored kind, has a delusive resemblance to amber, with which, though much softer, it has the common properties of igniting and becoming electrical by friction. I am satisfied that the Angola Copal is capable of being used and worked up into ornamental articles in the same way as amber, from a specimen which was finished by a turner at Loando, who had but a scanty knowledge of the treatment of amber. The interior of the Angola Copal pieces, when not mixed with earthy substances, or with remains of bark, is even glossy and transparent; but I have never observed insects in any of the numerous samples which, partly in Angola and partly in Lisbon, came under my notice; whilst in the Copal sent to Lisbon from the province of Mozambique, on the east coast of Tropical Africa, various hymenopterous insects are to be met with. The different colors of the Copal of Angola just described are connected more or less with its availability for varnishes, etc. Thus the Copal dealers distinguish three sorts, viz.:

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1. Red Copal Gum (Gomma Copal vermellia).
2. Yellow (G. C. amarella).
3. Whitish (G. C. bianca).

The red and reddish sorts furnish the best and finest varnish, and therefore are most in request and the dearest, whilst the whitish quality is sold at the lowest price.

Shortly before I left Loando, the market value of the different qualities was stated in the Price Current issued by the Chamber of Commerce, as follows:

1. Gomma Copal vermellia, 1 arroba (32 pounds) = 6,500 reis.*
2. Gomma Copal amarella, 1 arroba = 5,500 and 6,000 reis.
3. Gomma Copal bianca, 1 arroba = 3,000 and 3,500 reis.
4. Gomma Copal picada, 1 arroba = 2,000 reis.

The last named chiefly consists of the smaller soiled pieces of the three better qualities.

The export of Gum Copal from Angola as an article of trade commenced, as stated by the register of the Custom House (Alfandega Grande), during the years 1820 to 1825, but it is not until 1825 that any considerable quantity (e.g., 833 pounds) is quoted as having been imported thence.

From that time the export of Gum Copal from Angola has increased from year to year; so that it amounted in 1844 to 8,600 arrobas (275,200 pounds), and in the year

* Exchange: 7,000 reis Angola are equal to 4,500 reis Lisbon value, or £1 sterling.

following, 1845, it reached 24,000 arrobas (768,000 pounds). During the years 1850 to 1859 there was exported from Benguella alone, on the average, the enormous quantity of 50,000 arrobas (1,600,000 pounds) per annum, so that the total yearly export of Gum Copal from all the districts of Angola together may be estimated at 2,000,000 pounds. It is obvious that there must be a great difference in the export in different years, because the finding of the article depends on chance, and the gathering of it has often to be given up for a lengthened time, in consequence of the ravages of the neighboring warlike negro tribes, or on account of other unfavorable circumstances. Moreover, the quantity exported varies according to the demand for the article, existing in different countries, which, when increasing, runs up the prices, and stimulates the Copal gatherers to greater activity in their researches.

Part of this rich yield is shipped direct to European ports, another portion is sent via Lisbon, but the largest quantity is bought up in the various seaports of Angola by North American merchants. If we consider that not only from Angola, but also from most of the commercial towns on the west coast of Tropical Africa, more or less Gum Copal is exported every year, we can form an approximate idea of the enormous stock of this valuable resin treasured up in the respective districts of the African Continent, and the question arises naturally —

III. What is the origin of Gum Copal in West Africa in general, and especially of that found in Angola ? —

That the resin in question is an exudation from some tree, is shown not only by its resemblance to many other tree resins, but also by the remains of bark visible on the surface of many pieces, and further by the fact that some of them clearly exhibit a concave mark where bark is observed; and we may presume that in these places they were originally attached to the trees before falling off.

I have seen several samples so perfect in this respect, that from the arc of the concavity the diameter of the tree or branch from which they came might be determined with considerable exactness. Whether or not all the varieties of West African Gum Copal above mentioned, which differ in color and mercantile value, are produced from one species, or from several species of trees, is a question which cannot be settled with any degree of certainty until the origin of some one or other variety has been traced.

Here, however, I must premise that I have often noticed on pieces of Copal a clear transition of color from white to yellow, and from yellow to red, which leads me to the supposition that the different color is rather to be attributed to the age of the tree from which the Copal came, or to the condition of soil in which the tree grew, or to other climatological causes, than to a specific difference among the gum-yielding trees. For the present the most important question is whether the Gum Copal exported for so many years from Angola and other tropical countries on the west coast of Africa is still produced by trees, or whether it is to be considered (like

amber) a fossil resin which was produced in former geological epochs of the African Continent, or from trees which either do not now exist at all, or of which only a few scanty fossil remains are to be met with.

Although from my own observations during my residence in Angola I am firmly of opinion that the Angola Copal is a fossil resin, I think it right to mention and comment on the opinions and statements of those writers and travellers who assert that the resin is derived from living trees.

Oliveira Pimental, a learned Portuguese chemist, maintains, in a paper published at Lisbon in 1852,* that Gum Copal comes from the *Hymenaea verrucosa*, Lam. But this tree, which is also described by Hayne† as *Trachylobium martianum*, and which has been classified by Mr. Benthham as *Cynometra spruceana*, has never been found in Africa at all; it is an American tree, and can consequently in no way be regarded as the mother plant of the Angola Copal.

Ladislaus Magyar, a Hungarian traveller in South Africa, who during his journey often met with Copal gatherers, asserts with great precision‡ that the *Acacia nilotica*, which grows in abundance on the mountains behind the town of Benguella, furnishes the Gum Copal. Leaving out of the question whether the *Acacia nilotica*

* Relatório da Exposição agrícola de Lisboa, 1852, p. 51.

† Arzneigewächse, XI., tab. 17.

‡ Magyar hazì eleltrical Utazasai & Pesth, 1859, German edition, p. 59.

really occurs in the district of Angola, I cannot refrain from remarking that a traveller who finds in the forests of Tropical Africa species of *Platanus*, *Cornus*, *Quercus*, *Populus*, etc., with *Heliconia*, *Tillandsia*, and creeping *Tagetes*,* can hardly expect us to believe his botanical assertions.

It seems more likely that Magyar confounded Gum Copal with other gums, or perhaps in his inquiries as to its origin he was intentionally deluded by the negroes, who carefully try to keep secret the places where Copal is found.

To the two foregoing but little trustworthy statements regarding the origin of the Gum Copal, I will add a third, which, from the high scientific authority of the reporter, would be fully believed, if the reasons upon which the author bases his statement did not prove totally erroneous.

Dr. Klotsch, who, it is known, has described the greater portion of the plants collected by Dr. Peters in the province of Mozambique, asserts† that all African Copal originates from *Trachylobium Mossambicense*, and perhaps also from *T. Hornemanianum*, Hayne, trying to make it appear that no Gum Copal whatever occurs on the west coast of Africa, because, as he says, no mention is made of a tree in "Hooker's Niger Flora" from which the Copal could be gained. But as I have proved that by far the largest quantity of African Copal is not only ex-

* L. c., pp. 57, 61, 235, etc.

† Dr. W. Peters, Reise nach Mossambiqué, Bot., I., p. 22.

ported from the tropical west coast of that continent, but also that it is really found and constantly gathered there, and, further, as the *Trachylobium Mossambicense*, Klotsch, has hitherto nowhere been found on the entire western coast of Africa* by any one of the numerous scientific travellers who have visited that country, nobody will hesitate to regard Dr. Klotsch's view as erroneous; and I may therefore dispense with any further discussion of it.

I doubt whether even the Copal exported from the east coast of Africa comes solely from *Trachylobium Mossambicense*, Klotsch, as some kinds of the Copal which come from Mozambique bear a delusive resemblance to the animi resin found in the East Indies, and this latter resin, according to several trustworthy reports,† is not obtained from Leguminosæ, but from the *Vateria Indica*, Z., a tree belonging to the family of *Dipterocarpeæ*, and, like the Copal of Mozambique, it occasionally has various insects imbedded in it.

The peculiar designs appearing on many samples of the Mozambique Gum Copal, which extend with great regularity over a part of the surface, and which look like the rough side of a rasp, might be a hint for tracing its origin; but some very experienced botanists and pharmacutists to whom I have shown them have not as yet explained them. I may, I think, pass by the notices respecting the origin of the West African Copal which have hitherto

* *Vide* Bentham & Hooker, *f.*, *Genera Plantarum*, Vol. I., p. 583.

† Wight, *Illustrations of Indian Botany*, I., p. 86. Lindley, *Vegetable Kingdom*, p. 394.

appeared in pharmaceutical works published in England, Germany, and France, as most of them are founded on uncertain data and suppositions, or are simply compilations from older works which belong to a time when but a few coastal settlements of the tropical part of the African continent were accessible to scientific exploration.

An honorable exception among these publications is the paper by Dr. Daniell,* in the London Pharmaceutical Journal, which contains some very interesting genetical and mercantile data in relation to the gum resin of Tropical West Africa. This paper has, all the more claim for consideration and critical estimation, because the author resided personally as physician for several years in different places in West Tropical Africa, and it may be admitted that his views are founded more on his own personal experience than on the communications of others. Dr. Daniell divides all the Copals which come into the trade into East Indian, American, and African; and amongst those of the western coast of Africa, he distinguishes the Copal of North Guinea from that of South Guinea; but as many kinds of gum as well as Copal resin are found both in the countries north and south of the equator, the basis of this division is deficient. Still less correct is the subdivision by the author of the South Guinea Copal into Congo-Angola and Benguella Copal. It seems that he was not aware that several coast facto-

* Pharmaceutical Journal and Transactions, 1857, Vol. XVI., p. 387.

ries in Congo receive a large portion of their Gum Copal from different districts of Angola, and that the factories in Angola often have their stores furnished from the branch factories in Congo as well as from Benguella.

However, special attention should be paid to Dr. Daniell's communication on the origin of the Sierra Leone Copal, where he speaks of a particular tree as yielding the resin, which he represents to be the *Guibourtia copalifera* described by Mr. Bennett in the "Journal Linnean Society," Vol I., p. 150, and which in a late publication by Mr. Benthham is said to be a species of *Copaifera*, Linn, and is described by him as the *Copaifera Guibourtiana* in the last published part of the "Linnean Transactions."

According to Dr. Daniell, this tree grows in the higher mountain forests near Sierra Leone, and is conspicuous by its peculiar inflorescence and its bifoliated leaves, but he does not state whether he saw the trees *in situ* with the gum sticking to them, or whether he only received branches of the tree from negroes; and as regards the fruit of the tree, he admits that he has described it only by hearsay.

With reference also to the Copal resin furnished by the *Guibourtia*, he appears not to have been quite certain whether all the kinds described by him belong to the same species, for after having described one of these kinds of Copal, he adds: "The tree, independently of the ordinary Copal, affords other inferior sorts gathered from the trunks and branches of young or immature production;" and of these inferior sorts he says again in the next few

lines: "It is not improbable that different species of *Guibourtia* may yield the resin, which, however, at present remain undiscovered."

Leaving the reader to form his own conclusions from the passages I have quoted, I cannot help drawing attention to another passage in the same author's statements, where he speaks of the Copal which is brought by coasters from the rivers Malænzî and Pongas to Sierra Leone in the following manner: "Considerable quantities, the accumulation of years, are regularly washed down by the heavy currents of the rainy season from the mountain slopes, in the soil of which they were imbedded, and are consequently gathered in the bed or on the banks of rivers." *

This passage clearly proves that a considerable quantity of the Gum Copal exported from Sierra Leone is not gathered from trees, but is washed to the surface of the soil by the heavy rains, and is found on the banks of rivers or streamlets. Thus, like the Gum Copal of Angola, its origin is unknown, and, according to the author's own admission, it is (like the Gum Copal of Angola) much clearer than the Copal resin said to be gathered off trees in the neighborhood of Sierra Leone. My own stay in Sierra Leone was, to my regret, too limited, and I had no opportunity of making the necessary researches respecting the origin of the Copal resin exported from that colony; but what I heard about it from several natives, and also from a German merchant settled there, quite

* *L. e.*, p. 371.

agrees with the statement of Dr. Daniell just cited. Although I have not the slightest doubt that the *Guibourtia copallifera* really furnishes a Copal resin valuable in trade, yet it is clear, from the last-quoted passage of Dr. Daniell's paper, that a considerable portion of the Gum Copal of Sierra Leone is found stored in the earth, of which the origin is as yet totally unknown.

If the foregoing statement of Dr. Daniell respecting the origin of the Sierra Leone Gum Copal is considered insufficient, his assertion about the origin of the Angola Copal will be found still less satisfactory, because, although he himself has resided for some time in Loando, he admits that he obtained his information partly from the natives and partly from the work "Ensaïos," by José da Lima, a book which does full credit to the author's diligence and patriotism, but which, in its comments on the natural productions of Angola and their origin, is thoroughly unscientific.

We can hardly agree with what Dr. Daniell says about the origin, even of the softer gum resins enumerated by him under the name of Gum Animi, as he appears to have obtained them from the *Hymenœa courbaril*, or from another kindred species, and which, as he says, is abundant in Senegambia. But neither the *Hymenœa courbaril*, nor any other species of this genus (of which at present eight are known) has ever been found on the African Continent; on the contrary, they all belong to the flora of America, and therefore cannot be taken into account when the origin of the African gum resin is in question.

Having now reviewed the various opinions of African travellers and other scientific authorities, I shall proceed to consider the ideas prevalent among the natives themselves respecting the origin of Gum Copal in Angola.

Many of the natives maintain that the Copal still grows on different trees, but that it acquires its excellent qualities as a useful resin by dropping off and sinking several feet deep into the soil, whereby it is cleaned, and obtains after the lapse of many years its hardness, inflammability and transparency.

The opinion (which, if correct, would show some analogy between the formation of Copal, and that of coal) was not communicated to me by native Africans alone, but also by some European settlers in Loando, Ambriz, and Benguella.

If a portion of this Ethiopian hypothesis is wholly erroneous, still the other clearly indicates that the inhabitants of the country themselves, where the Gum Copal is gathered, look upon it as a kind of fossil production. In April, 1854, shortly after my arrival on the west coast of Africa, at a time when I hoped to find the Gum Copal tree still in existence, I was told by a native of some education that Gum Copal was furnished by certain trees, called by him Muve, growing near the Cabo Lombo, eight to ten miles south of Loando, where I might find a small quantity, although perhaps in an immature condition.

This statement was corroborated shortly afterwards by a European druggist established in the same town, and

who was considered somewhat learned by his fellow citizens. I therefore immediately started off for the spot indicated.

I found, however, only a few scattered trees of the Combretaceæ family, certainly exhibiting some blackish gum; but this gum, when masticated or placed in water, quickly dissolved, showing, to my great disappointment, that it was not a resin, still less Gum Copal. When I mentioned my failure to my informers on my return to Loando, both of them asserted that the gum which I had found really was young Gum Copal, but that it must first fall off the tree, penetrate into the ground, there ripen, and be transformed into real Copal. Nearly the same thing happened to me in September, 1857. Descending from the highlands of inner Angola into the coastal region, I met one evening a party of Gum Copal gatherers encamped round a fire, sorting Copal collected during the day.

I immediately ordered my caravan to stop for the night, and to put up near the party, fully hoping that I should be certain now to find out the Copal tree. Having saluted my heroes with the friendly "Bocuetu" of the Bunda dialect, treating them also to a few glasses of rum, I gradually turned the conversation to the place where they had found the Copal.

After some hesitation, one of the elder negroes said that the Copal in their possession had been collected in wooded sand hills near Mongolo, a station which I had passed with my caravan in the morning.

The half-starved condition of my caravan did not admit of my interrupting my journey for several days by a retrograde march; nevertheless I determined to visit on the next day the spot indicated by the Copal gatherers; and by giving them a few presents I induced two of the party to accompany me. We arrived there in five hours, about noon. Before we came to the forest which adorns the heights of the sand mountains, which are intercepted here and there by plots of marl stone, I observed that the sand had been freshly dug up in many places, and I felt convinced that the negroes had not deceived me, but had really brought me to the place of their operations on the previous day.

This Copal field extended almost into the middle of the forest, which (although in some places *Celastrus*, *Diospyrus*, *Combretum*, and a few *Acacias* were seen) consisted chiefly of a tree I had formerly met with in isolated groups in the district of Golungo Alto, and more frequently in the district of Cazengo, and which is called by the natives Calalanza.*

Now this was pointed out to me by the two Copal gatherers as the Copal-yielding tree. I tried hard to discover some resin on any one of them, but without success.

* This tree, which only occurs here and there throughout the forests in the districts of Golungo Alto and Cayenzo, but which covers large tracts in the lowest littoral region, especially on the lower edge of the primitive forest region, belongs to the Leguminosæ; and Mr. Benthham, to whom I submitted flowering specimens, has described it as a new species of *Cynometra* (*C. laxiflora*). See Transactions of the Linnean Society, Vol. XXV., p. 318.

My companions were not in the least concerned or confused, but assured me that the exuded Copal was washed off by the heavy rain-falls, and, after sinking into the soil, ripened there and came to perfection; so I had to regret that in this instance, also, my researches led only to a negative result. Several subsequent attempts that I made in the districts of Benguella and Mossamedes yielded the same negative result. At one time I was inclined to believe that the tree which yielded the large quantity of Copal found was either very scarce or probably no longer existed.

After the foregoing remarks I may perhaps assume with some certainty that the West African Copal, and probably all gum resin exported under this name from Tropical Africa, may be looked upon as a fossil resin produced by trees, which in periods long since past adorned the forests of that continent, but which at present are either totally extinct or exist only in a dwarfed posterity. As evidence in support of my views, I should point in the first place to the petrified crust on the surface of this Copal; next, to its admitted occurrence in the earth, often at a considerable depth, and, lastly, to its great resemblance to amber.

Besides this positive evidence, I may also be permitted to establish my views inductively in a negative manner.

If we consider the large quantity of Copal gathered in Angola, and all along the coast of Tropical West Africa, we are led naturally to the conclusion that the trees yielding it could not be scarce if still in existence, but

ought to be abundant and widely distributed, and that the Copal resin produced by them must be enormous, and could not well escape observation; and yet, favored by circumstances as I was, during several years of residence in and travel through most of the districts of Angola, I could not find out even a single living tree with resin similar to Gum Copal; I am therefore confirmed in my opinion that the tree in question must either be very scarce, or, what is more probable, is extinct, and that West African Copal is really a fossil resin.

That of these Copal-yielding trees (which certainly at one time must have been growing in large numbers in and near the widely extended region where Copal is so abundantly found at present) only a few fragmentary remains of bark should have hitherto been discovered is the less surprising, if we take into consideration that Tropical Africa, the home of this Copal, is at the present moment the least explored continent, and further bear in mind that when another analogous resin, amber, became known and brought into practical use, more than 500 years elapsed before the learned Dr. Goeppert (whilst pointing to its fossil nature) succeeded with some degree of probability in tracing its origin to coniferous trees.

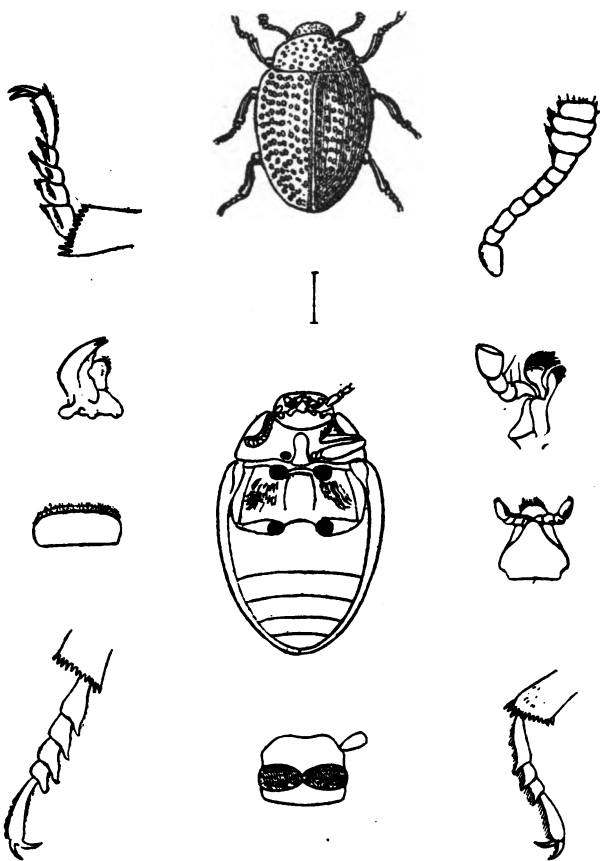


PLATE II. HOPE.



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PLATE III. HOPE.

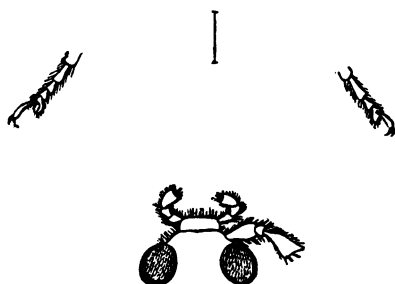
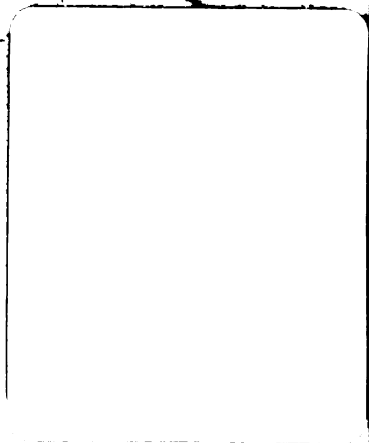


PLATE IV. HOPE.



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